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(Complete in ten numbers)

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ERRATA

Page 12, line 6, "F-19-12" should read "F-19-2".
Page 52 and table of contents, June issue, "VALENTE VILLEGAS, L. A. YNALVES, AND A. M. GATAN" should read "VALENTE VILLEGAS, L. A. YNALVEZ, AND A. M. GATAN."
Page 252, line 4, "*Hibiscus subdariffa*" should read "*Hibiscus sabdariffa.*"
Page 355, line 17 from bottom, "*kulutkulutan*" should be "kulutkulutan."
Page 380, line 5, "sugar" should read "auger."
Page 416, last line, add after Rept. 5 "p. 51-59."
Table of contents, November issue, "571" should read "471."
Page 512, footnote 1, "Temperative" should read "Temperature."
Page 569, line 5, "Philippine boll-weevil" should read "Philippine cotton boll-weevil."
Page 569, line 17, "bee" should read "beetle".
Page 569 line 22, "*Graptoblatta motulata* (Ha-an)" should read "*Graptoblatta notulata* (Haan)."
Page 570, line 23, "Family" should read "family".
Page 570, line 26, "*Graptoblatta motulata* (Ha-an)" should read "*Graptoblatta notulata* (Haan)."
Page 612, line 2 from top, "rustry" should read "rusty."
Page 635, line 9 from bottom, "1938" should be "1928."
Table of contents, February issue, "881" should read "781."
Page 734, line 12 from bottom, "*Prelinary*" should read "*Preliminary*".
Last two pages, February issue, page "881" should be page "781" and page "882" should be page "782".

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ORIGIN AND EARLY HISTORY OF COCKFIGHTING IN THE PHILIPPINES [1]

MANUEL ARTIGAS Y CUERVA

Cockfighting is a very ancient institution in the Philippines. According to authorities, it was introduced into the Islands during the earlier part of Spanish rule. It came from Mexico, where it was very popular. It is said that the government decided to establish this game in order to attract the recalcitrants. Doubtless, the pastime so greatly distracted the natives, who devoted most of their time to it, that in 1776 Don Simon de Anda y Salazar instructed the local officials to allow cockfights only after the high mass on holidays. Matches, according to the same order, were to be made exclusively in public places, under the supervision of cockfight judges, to avoid rancor and so that this vice might not adversely affect agriculture. It had then come to such a pass that the game constituted the daily occupation of the masses. So many difficulties were encountered in the attempts to eradicate the evil that the said Doctor Anda, dissatisfied with the measures that had already been taken, decided to regulate the cockpits.

Later, Governor Basco y Vargas in 1784 instituted cockfighting as a government enterprise in the provinces of Tondo, Bulacan, Pampanga, Laguna, and Cavite, under the administration of the public treasury. The first concession was awarded in 1788 to Don Agustin Zanoli for the sum of 6,000 pesos a year. The lease, however, did not produce the expected results. The inhabitants avoided the cockpits, because it was more convenient and cheaper to play elsewhere. The consequence was that gate receipts dwindled from day to day, and the lessee finally solicited aid from the government to cover his losses. In 1789, a cockpit ordinance was enacted and through succeeding years many persons were becoming convinced that cockfighting should be prohibited outside the cockpits maintained by the lessees.

Cockfighting must have received an impetus when the decree of June 1, 1808, authorized cockfights on the patron saint's day of every town when this falls on Sunday. By this time Mr. Cramer held the concession and then later, on September 15, 1847, the paymaster-general of the army and exchequer adopted a liberal policy of allowing every inhabitant to engage in the cockfighting business by constructing the proper cockpits, but not without previously securing the necessary license.

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[1] Translated by L. B. Uichanco from ARTIGAS Y CUERVA, MANUEL. 1916. Historia de Filipinas, p. 374-376, footnote (231). Manila: Imprenta "La Pilarica."

A learned and diligent official, Don José Manuel Aguirre Miramon, the distinguished magistrate of the Audiencia of Manila, who spent much time in a study of the different branches of government administration, wrote reports and published documents of unusual interest. He dealt, among other things, with the question of cockfighting. A keen observer, he summarized in 1859, from his visits to the majority of the provinces in the Archipelago, in a code of rules on cockfighting the essential features of the usages that had been evolved up to that time in connection with this game. He set the limit of 50 pesos to a bet, pointing out that a larger sum gave it the form of a prohibited game. At the same time, he did not forget to fix a scale of fines against those who played outside the cockpits. These rules were approved by the royal decree of May 21, 1861, and they remained in force for the rest of the Spanish régime, doubtless because they were appropriate rules, in which police regulations were given, minors were debarred, the game was regulated, and procedures were established for the guidance of cockpit judges.

Cockfighting yielded in 1813 an income of from thirteen to sixteen thousand pesos and in 1894 the receipts from this source were estimated at one-hundred and forty-eight thousand pesos. However, in the interval of time that the Philippine Republic existed, a decree promulgated by President Aguinaldo cancelled all cockpit permits, on the ground that this vice had no other effect than to ruin the inhabitants, while the public treasury was scarcely benefited. Thus cockpits practically died out and did not reappear until the establishment of American civil government in these Islands. Upon the creation of the Philippine Assembly, the advantages and disadvantages of continuing the cockpits were amply discussed. Despite the fact that from a moral angle the question left much to be desired, a large part of the population requested its continuation and the law-makers acceded, but not without imposing certain restrictions.

COMMERCIAL TESTS OF SELECTED ELON-ELON RICE STRAINS PRODUCED BY INBREEDING[1]

J. M. CAPINPIN AND M. D. PANGALANGAN
Of the Department of Agronomy

Inbreeding rice followed by selection has already been found in this College to be a practical method of increasing rice yield. Very recently, high yielding inbred strains of Hambas have been isolated. Elon-elon, one of the important commercial varieties, has also been made to produce new strains by inbreeding, and after a series of comparisons with the parent variety and eliminations, four strains have been found to be high yielders. However, these comparisons had only been made in plant-to-row and small plot plantings; hence, it was advisable to carry out comparative tests in larger cultures.

Review of literature

Koch (1930) reported that up to 1915, pure line selection (without strict inbreeding) of rice in Java was a failure which he attributed to (a) the insufficient homozygosity and superiority of the lines, and (b) the fact that the mixture of line and hybrids such as found in the population had the advantage of being pliable and, therefore, more suited to varying conditions encountered in general cultivation. Inbreeding by bagging and, in some instances, by planting wide apart had been in use since 1922, and the results obtained in 1927-1928 were remarkable.

Doctor Mendiola initiated the work of inbreeding rice to be followed by selection in the College of Agriculture, the first results of which were reported by Mercado and Juachon (1933), who isolated two strains of promising importance from an inbred Hambas rice. The investigation reported in this paper is a part of this series of pure line selections and involves the variety Elon-elon.

Object of the present work

The object of this work was to compare the yielding capacity and other important agronomic characters of four inbred strains of Elon-elon rice with one another and with the parent.

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[1] Experiment Station contribution No. 1218.

Time and place of the work

This work was begun in May, 1936, and concluded in March, 1937. The field experiments were all conducted in the lowland rice fields in the Experiment Station, College of Agriculture, Los Baños, Laguna.

MATERIALS AND METHODS

The materials used in this experiment consisted of selected inbred strains of Elon-elon rice: A-5-36, D-11-18, F-19-2, G-33-4, and the parent variety. These were produced by the plant breeding division, Department of Agronomy. The history of the seed material may be given briefly as follows:

In 1932-1933 rice season, seventy-one plants selected in the field on the basis of vigor were inbred by the plant breeding class under supervision of the senior author by bagging the plants at the booting stage. The seeds of these plants were tested head-to-the-row in the 1933-1934 rice season, and thirty-one of them were selected on the basis of tillering capacity and yield. Seeds from these thirty-one strains were sown in 1934-1935 for comparative tests and from this culture seven apparently superior lines were selected. In 1935-1936, a comparative test of the seven lines in replicated plots was conducted. After a rigid comparison with the original parent variety, four strains were found to be higher yielders than the parent. These represent selections from the first generation inbred Elon-elon rice plants and are the strains used in this work. The control variety was the original stock Elon-elon maintained in culture since 1932, when the first inbreeding was performed.

Seed bed

A rice paddy adjacent to the main field with water always available during the rainy season was selected as a seed bed. The bed measured 20 meters wide and 25 meters long. The land was divided into five plots each about 5 meters wide and 20 meters long, leaving a space about 2 meters wide between them.

Preparation of seed bed

The common wet method of preparing the seed bed in the College lowland rice field was followed. The seed bed was plowed once with a native lowland rice plow on July 13, 1936, and subsequently harrowed three times to insure a thorough puddling and levelling of the field.

Sowing

Treatment of seeds before sowing. The seeds were placed in clean gunny sacks properly labeled and soaked in running water in the irrigation ditch of the lowland rice farm. Each strain had two labels, one inside the sack mixed with the rice, and the other tied outside with wire; thus, there was no chance of losing the identity of the strain in the sack. After 24 hours, the rice seeds were removed from the water and placed in the shade for another 24 hours, to facilitate germination.

Method. The seed of the different strains and parent variety were sown dry uniformly on the prepared seed bed on August 4, 1936. In order to prevent mixing the different strains with the parent variety, the sack of each strain was placed near the seed bed. Using a basket, the farmer broadcasted each strain separately on the seed bed. Banana stems were placed between rows to prevent mixing of the seeds. All plots were labeled according to the strain number, and a diagram of the seed bed was made.

Care of seed bed. Open dikes, through which surplus water was drained off, were closed immediately after the seeds had been sowed to prevent loss of seeds and mixture of the different strains by water. The seed bed was fenced with two lines of barbed wire to prevent animals from getting inside. Every precaution was taken to provide identical conditions for all the strains and the parent variety.

The field

Size and number of plots. The field is rectangular, with an area of 12,500 square meters. It was divided into 25 paddies, each measuring 25 meters by 20 meters.

The planting of each strain and parent variety was replicated five times. In order to minimize the error from the effect of soil variability, the different strains and parent variety were distributed throughout the field.

Preparation of the field. The field was prepared in much the same way as in the preparation of the seed bed. The field was plowed once on August 17, 1936, and harrowed thoroughly three to four times.

Transplanting

Pulling up the seedlings. The seedlings were pulled up by hand and tied into small bundles about 6 to 7 centimeters in diameter on September 14, 1936. They were then 41 days old. The mud clinging to their roots was washed off. The bundled seedlings were topped to about one fourth of their height and piled at one end of the seed bed.

Distribution of bundled seedlings. The number of bundles of seedlings placed in one paddy was between 90 to 120. These seedlings were sufficient to plant a paddy of 500 square meters.

Rate and distance of planting. The seedlings were transplanted on September 15, 1936. They were planted 25 centimeters each way, with 3 to 4 seedlings to a hill. The rate of planting depended upon the vigor and size of the seedlings. On the whole, the method of planting was similar to that done in commercial planting.

Care of the transplanted seedlings. Immediately after the seedlings had been transplanted, open dikes, through which surplus water was drained off, were closed. Water was not turned into the field until the transplanted seedlings were ten days old. By that time, the young rice plants were so firmly established in the soil that there was no danger of their being washed away. In the later part of September, rain was so scarce that the young plants suffered from temporary dryness. In the early part of October, rain was plentiful, so the young plants recovered from the slight effect of the temporary dryness, and there was no necessity for irrigating the rice field.

EXPERIMENTS AND RESULTS

Observation of the different strains and parent variety

Germination. The seeds of the different strains and parent variety germinated on the third day after sowing. The selected strains and the parent variety gave about the same percentage of germination.

Behavior of plants in the seed bed. The growth of the different strains and parent variety was observed from time to time in the seed bed. Three to four days after germination, the seedlings were of more or less uniform height in the seed bed. There were no noticeable differences in height, vigor, and color of leaves. They were pale to light green throughout. A slight variation in the growth of the seedlings was observed when they were three to four weeks old. These differences in height and vigor of the plants were marked even before transplanting. It was observed that strains A-5-36 and F-19-2 were the most vigorous and had the most uniform stand in the seed bed. Strains D-11-18 and G-33-4 ranked second, but they seemed to lack uniformity in the growth of the seedlings, although they were slightly more uniform than the parent variety.

Growth of plants in the field. The transplanted seedlings readily recovered from the effect of transplanting after a few days. The plants required about two weeks to attain a firm stand. The different strains and the parent variety grew uniformly for some time, but after two months or more, some of the plants of the different strains showed marked variation in growth and height. In all the plots planted with the parent variety, or control, the plants had a poor stand and variable growth. This was noticeable when compared with strains A-5-36 and F-19-2. In general, strains A-5-36 and F-19-2 seemed to grow similarly, as their differences in the plots were slight. The other two strains, D-11-8 and G-33-4, showed little difference from the parent variety as to uniformity of growth and vigor of the plants.

Time of blooming. The data of flowering and period of maturity of the different strains and parent variety were recorded. A given strain planted in different plots was found to bloom and mature at different dates although the variations ranged from one to three days only.

Susceptibility to pests and diseases.[2] About three weeks or more after transplanting the seedlings, a sporadic attack of the rice swimming caterpillar (*Nymphula depunctalis* Guen.) was observed in the different paddies.

Owing to the attack of the rice bug (*Leptocorisa acuta* Thunberg), empty grains were occasionally found in some panicles. As usual also, the cultures attracted the common rice weaver (*Munia jagori* Martens), but they were driven away by the College tenants who stayed most of the day in the rice field.

Two rice diseases were found in the field. These were false smut caused by *Ustilaginoides virens* (Cke.) Tak. and *Helminthosporium* disease of rice caused by *H. oryzae* Breda de Haan.

Lodging. The plants lodged when they were nearing maturity. In general, however, lodging occurred in almost all paddies planted to the different strains and control varieties.

Period of maturity. The strains and parent variety matured at different times, but their differences were slight (see table 1). When the lowest grains in the panicles were straw color, they were considered fully mature.

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[2] The insect pests mentioned in this paper were identified by Dr. L. B. Uichanco, of the Department of Entomology, and the diseases, by Mr. M. S. Celino, of the Department of Plant Pathology, College of Agriculture.

Tillering at maturity

One week before harvesting, the tillering capacity of each strain and parent variety was determined. This was done by obtaining at random twenty hills in each plot (100 hills in each strain and parent variety), indicating the number of bearing and non-bearing culms. A culm was considered non-bearing when it did not produce flowers. Some plants booted but did not show flowers; hence, these were considered non-bearing. The number of tillers, bearing and non-bearing, per hill was counted and recorded. While it is true that the plants were not set one to the hill, nevertheless, the rate of distribution may be considered uniform, and hence, the variation in tillering would serve as individual variation of the strains studied. The total number of tillers and bearing culms per hill were subjected to a frequency distribution study and their variation constants determined (see tables 2 and 4).

Harvesting, threshing, and cleaning

The plants were harvested on January 25, 1937, with a serrated knife locally known as *pangápas* (Tagalog). Because of inclement weather, the strains that matured a little earlier were not harvested ahead of time. To prevent mixing of the harvests, two harvesters were assigned to each plot; this made 50 to the whole field. Soon after harvesting, the rice was threshed at each plot on a buri mat provided by the harvesters. During the threshing, care was taken that no grain was left on the panicle. Each harvester threshed his own harvest.

After being threshed, the rice grain was cleaned by being dropped from a winnowing basket at a certain height to a buri mat on the ground; in this way the wind separated the chaff and empty grains from the filled ones.

The clean rough rice was spread on the threshing mat to dry for some time. After drying, the harvest in each plot was placed in a sack, properly labeled according to the strain number and plot number. The rice from each plot was weighed separately on a Fairbanks balance, and the weight of the sack deducted. Close supervision and careful observation in the field were adhered to in all operations to prevent mixtures of harvests.

Computation of yield per hectare

The actual yield of each strain per plot was found by weighing the cleaned palay harvested in each plot. The yield per plot was given in kilograms and this, divided by 44 kgm.,[3] gave the yield in cavans. Then the yield of each strain in the different plots was compiled and the yield per hectare computed (see table 6). The computation was based on the actual yield in kilograms and in cavans per plot of 500 square meters.

DISCUSSION OF RESULTS

Variation of the strains

Uniformity of growth and general vigor of the plants. When the plants were still in the seed bed, differences in height and uniformity of growth of the different strains and parent variety were clearly noticeable. Strains A-5-36 and F-19-2 gave the best stand of seedlings having a more or less uniform growth and evidently being the most vigorous. Those of strains D-11-18 and G-33-4 were only slightly better than the control (parent variety).

The uniformity and general vigor of the different strains and parent variety were observed in the different plots in the field. It was found that the control plants were the most variable in their growth. Strain A-5-36, in all the five plots except one, had the most uniform growth. Strain F-19-2 ranked second to A-5-36 as to uniformity of growth and vigor of plants. Strains D-11-18 and G-33-4 were more or less variable in growth of plants in all the plots.

Tillering power and bearing culms. Table 2 shows the frequency distribution of plants as regards the number of tillers per hill. Table 4 shows the frequency distribution of plants based on the number of bearing culms per hill. It will be noted that strains A-5-36 and F-19-2 gave the highest mean number of tillers and bearing culms.

Tables 3 and 5 show the comparison of the number of tillers and bearing culms per hill. No significant differences in the production of tillers and bearing culms per hill were observed between strain G-33-4 and the control, and between strains A-5-36 and F-19-2; while strains A-5-36, F-19-2, and D-11-18 gave significant differences when compared with strain G-33-4 and the parent variety.

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[3] In this computation, 1 cavan of palay was considered as weighing 44 kgm. (Statistical Handbook of the Philippine Islands. 1932).

It is interesting to note in tables 2 and 4 that the variations in tillering and in total number of culms, whether bearing or not, were greater in the parent variety than in each of the strains. Table 2, for instance, shows that while the mean number of tillers in the parent variety was less than that of the different strains, the corresponding coefficient of variation was higher. The control variety gave a coefficient of variation of 26 per cent, whereas the different strains gave from 21 to 25 per cent. In table 4 the coefficient of variation for the number of bearing culms for the control was 25 per cent, whereas for the strains, it ranged from 20 to 25 per cent. In general, therefore, on the basis of coefficient of variation, the selected strains exhibited a greater uniformity in tillering habit than the parent.

Period of maturity. It will be noticed in table 1 that there was not much difference in the length of maturity of the different strains and the parent variety. Strain A-5-36, which was the latest maturing strain, gave a difference of 1.4 days from the parent variety, while strain D-11-18 matured almost at the same time as the control.

Yield of the different strains and their rank. Table 6 shows the actual and the mean yields of each plot and the computed yield per hectare of the different strains studied. The actual yield of each strain and the control varied in each plot. This may be attributed to soil variability. Strain G-33-4 gave the lowest mean yield per hectare, but its difference from the control was insignificant. Strain A-5-36 gave the highest mean yield of 75.72 ± 1.14 cavans per hectare, followed by strain F-19-12, which produced a mean yield of 71.72 ± 1.65 cavans per hectare. Strain D-11-18, which ranked third, gave a mean yield of 64.72 ± 1.11 cavans per hectare. The performance of strain G-33-4 was disappointing, for its yield of 53.08 ± 3.63 cavans per hectare was even less than the control, the yield of which was 54.33 ± 2.32 cavans per hectare.

Table 7 shows a comparison of the yields between the different strains and the control. All the strains, except G-33-4, gave significant differences in yield over the parent variety.

A parallel test under supervision of the senior author was also conducted in the same year but in a different field. In this test the replicated plots for each strain differed because the remaining seed was planted to as many paddies as it could cover. The data obtained in this parallel culture are given in table 8. It is evident from the results obtained that strains A-5-36 and F-19-2 maintained their superiority in yield over the parent variety. Strain D-11-18, on the other hand, yielded only as much as the parent. In the experimental culture, strain D-11-18 gave a significant difference over the control, whereas G-33-4 produced an insignificant difference. Because of the inconsistency of yield of strains D-11-18 and G-33-4 on the commercial planting, as shown by their performance in both parallel and experimental tests, it was thought advisable to select finally only strains A-5-36 and F-19-2, which statistically showed significant increases in yield over the parent variety in the two cultures. Strain A-5-36 outyielded the parent variety by 30.8 per cent in experimental culture and 30.9 per cent in parallel culture, showing an average increase of 30.85 per cent over the unselected variety. Strain F-19-2 outyielded the control by 30.1 per cent in experimental culture and 28.2 per cent in the parallel test, giving an average increased production of 29.6 per cent over the parent variety.

From these two sets of commercial planting, it is evident that strains A-5-36 and F-19-2 consistently maintained their superior productive capacity over the unselected parent variety. It would seem that rice, although naturally to a large extent self-pollinating, is heterozygous for factors affecting yield. This heterozygosity may be assumed to exist in a commercial variety like Elon-elon. When Elon-elon was selfed or inbred, even for one generation, its various yielding biotypes came into expression. Apparently, the two lines A-5-36 and F-19-2 maintained their superiority even though their subsequent parent plants were not artificially inbred. Their capacity for high yield was maintained constantly in several sets of commercial planting.

SUMMARY AND CONCLUSIONS

1. This paper reports the results of a commercial planting of four apparently high yielding strains selected from first generation inbred-Elon-elon rice.

2. The selected strains and parent variety did not differ significantly from one another in the length of flowering and maturity periods.

3. Of the four strains tested, strains A-5-36 and F-19-2 were found to produce the greatest number of tillers and bearing culms per hill. Their tillering capacity was significantly heavier than the parent variety.

4. In the experimental culture, three strains gave a significantly higher yield per hectare than the parent variety. Strain A-5-36 gave 21.40 ± 2.58 cavans higher; F-19-2, 17.40 ± 2.85 cavans; and D-11-18, 10.40 ± 2.57 cavans. The control only yielded 54.33 ± 2.32 cavans per hectare.

5. In a parallel culture, strains A-5-36 and F-19-12 were also found to be the highest yielders. Strain A-5-36 gave a difference of 21.86 ± 3.41 cavans and strain F-19-2 a difference of 16.03 ± 4.21 cavans over the parent variety, which yielded 56.34 ± 3.26 cavans per hectare.

6. Strain A-5-36 outyielded the unselected Elon-elon variety by 30.85 per cent, while strain F-19-2, by 29.6 per cent. Their superiority over the parent strain has been maintained for the past three seasons, in both small plot and commercial plantings.

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TABLE 1

Dates of flowering and periods of maturity of the different inbred strains of Elon-elon rice

STRAIN	PLOT NO.	DATE OF FLOWERING	DAYS FROM SOWING TO FLOWERING	DAYS FROM FLOWERING TO MATURITY	DAYS FROM SOWING TO MATURITY
		1936	*days*	*days*	*days*
A-5-36	1	December 11	129	43	172
	2	” 13	131	43	174
	3	” 14	232	42	174
	4	” 13	131	41	172
	5	” 14	132	42	174
Average			131.0	42.2	173.0
D-11-18	1	December 12	130	40	170
	2	” 11	129	41	170
	3	” 13	131	42	173
	4	” 12	130	43	173
	5	” 12	130	43	173
Average			130.0	41.2	172.0
F-19-2	1	December 14	132	42	174
	2	” 12	130	44	174
	3	” 13	131	43	174
	4	” 12	130	44	174
	5	” 12	130	42	172
Average			131.0	43.0	173.6
G-33-4	1	December 13	131	39	170
	2	” 12	130	43	173
	3	” 11	129	44	173
	4	” 12	130	43	173
	5	” 13	131	43	174
Average			130.2	42.4	172.6
Control (parent variety)	1	December 11	129	41	170
	2	” 11	129	41	170
	3	” 12	130	42	172
	4	” 13	131	43	174
	5	” 12	130	42	172
Average			129.8	41.2	171.6

TABLE 2

Frequency distribution of plants based on the number of tillers per hill

TILLERS PER HILL	FREQUENCY				
	A-5-36	D-11-18	F-19-2	G-33-4	Control (parent variety)
number					
5	—	—	—	1	2
6	—	1	—	4	6
7	2	6	1	6	10
8	3	3	2	9	12
9	1	6	7	20	12
10	10	11	4	15	13
11	9	15	8	16	14
12	8	12	13	12	13
13	7	16	10	5	7
14	11	9	19	2	6
15	15	8	12	4	2
16	16	4	11	5	1
17	8	2	5	0	1
18	5	5	4	1	1
19	3	2	1	—	—
20	2	—	3	—	—
Mean	13.9 ± 0.2	12.3 ± 0.2	13.6 ± 0.2	10.4 ± 0.2	10.2 ± 0.2
Standard deviation ..	2.9 ± 0.1	2.9 ± 0.1	2.8 ± 0.1	2.6 ± 0.1	2.7 ± 0.1
Coefficient of variation	21.7 ± 0.1	23.9 ± 0.1	20.5 ± 0.1	24.8 ± 0.1	26.4 ± 0.1

TABLE 3

Comparison of tillers per hill of 100 hills taken at random in each strain at maturity

STRAINS COMPARED	DIFFERENCE OF MEAN NUMBER OF TILLERS PER HILL	DIFFERENCES
(A-5-36) — Control	3.8 ± 0.3	Significant
(D-11-18) — Control	2.1 ± 0.3	"
(F-19-2) — Control	3.4 ± 0.3	"
(G-33-4) — Control	0.3 ± 0.3	Insignificant
(A-5-36) — (G-33-4)	3.5 ± 0.3	Significant
(A-5-36) — (D-11-18)	1.7 ± 0.3	"
(A-5-36) — (F-19-2)	0.3 ± 0.3	Insignificant
(F-19-2) — (G-33-4)	3.1 ± 0.3	Significant
(F-19-2) — (D-11-18)	1.3 ± 0.3	"
(D-11-18) — (G-33-4)	1.8 ± 0.3	"

TABLE 4

Frequency distribution of plants based on the number of bearing culms per hill

BEARING CULMS PER HILL	FREQUENCY				
	A-5-36	D-11-18	F-19-2	G-33-4	Control (parent variety)
number					
5	—	—	—	3	3
6	—	2	—	2	6
7	2	5	2	6	13
8	3	4	1	12	14
9	4	6	7	19	13
10	8	12	5	17	11
11	9	15	11	14	14
12	9	11	10	10	11
13	6	15	12	5	10
14	13	9	17	4	3
15	14	10	12	3	2
16	16	2	11	4	—
17	7	2	5	0	—
18	4	6	3	1	—
19	4	1	1	—	—
20	1	—	3	—	—
Mean	13.7 ± 0.2	12.1 ± 0.2	13.4 ± 0.2	10.3 ± 0.2	9.7 ± 0.2
Standard deviation	3.1 ± 0.2	2.9 ± 0.1	2.7 ± 0.1	2.6 ± 0.1	2.4 ± 0.1
Coefficient of variation	22.8 ± 0.1	24.2 ± 0.1	20.3 ± 0.1	25.1 ± 0.1	25.2 ± 0.1

TABLE 5

Comparison of bearing culms per hill of 100 hills taken at random in each strain at maturity

STRAINS COMPARED	DIFFERENCE OF MEAN NUMBER OF BEARING CULMS PER HILL	DIFFERENCES
(A-5-36) — Control	4.1 ± 0.3	Significant
(D-11-18) — Control	2.5 ± 0.3	"
(F-19-2) — Control	3.8 ± 0.3	"
(G-33-4) — Control	0.6 ± 0.2	Insignificant
(A-5-36) — (G-33-4)	3.5 ± 0.3	Significant
(A-5-36) — (D-11-18)	1.6 ± 0.3	"
(A-5-36) — (F-19-2)	0.3 ± 0.3	Insignificant
(F-19-2) — (G-33-4)	3.2 ± 0.3	Significant
(F-19-2) — (D-11-18)	1.3 ± 0.3	"
(D-11-18) — (G-33-4)	1.9 ± 0.3	"

TABLE 6

Actual and mean yields per plot and computed yield per hectare of the different strains studied

STRAIN	ACTUAL YIELD OF CLEAN PALAY IN EACH PLOT OF 500 SQUARE METERS										MEAN YIELD PER PLOT		COMPUTED YIELD PER HECTARE	
	PLOT 1		PLOT 2		PLOT 3		PLOT 4		PLOT 5					
	kgm.	*cav.*	*kgm.*	*cav.*	*kgm.*	*cav.*	*kgm.*	*cav.*	*kgm.*	*cav.*	*kgm.*	*cav.*	*kgm.*	*cav.*
A-5-36	169.7	3.86	154.5	3.51	168.5	3.82	163.4	3.71	177.4	4.03	166.7 ± 2.55	3.79 ± 0.06	3334.0 ± 51.06	75.72 ± 1.14
D-11-18	145.4	3.30	129.2	2.94	159.7	3.62	136.4	3.10	141.8	3.22	142.5 ± 3.42	3.24 ± 0.07	2850.0 ± 47.78	64.72 ± 1.11
F-19-2	176.2	4.00	145.4	3.30	162.1	3.68	164.6	3.74	141.4	3.21	157.9 ± 1.32	3.59 ± 0.10	3158.8 ± 72.58	71.72 ± 1.65
G-33-4	96.9	2.20	144.3	3.28	132.1	3.00	81.8	1.86	129.1	2.93	116.8 ± 7.94	2.65 ± 0.18	2336.8 ± 158.55	53.08 ± 3.63
Control (parent variety)	128.2	2.91	96.2	2.19	141.2	3.21	119.5	2.72	112.0	2.55	119.4 ± 5.11	2.72 ± 0.11	2388.4 ± 102.10	54.33 ± 2.32

TABLE 7

Comparison of yield between strains and control

STRAINS COMPARED		DIFFERENCE IN YIELD PER HECTARE	DIFFERENCES
(A-5-36)	— Control	21.40 ± 2.58	Significant
(D-11-18)	— Control	10.40 ± 2.57	”
(F-19-2)	— Control	17.40 ± 2.85	”
(G-33-4)	— Control	1.25 ± 4.31	Insignificant
(A-5-36)	— (G-33-4)	22.64 ± 3.80	Significant
(D-11-18)	— (G-33-4)	11.64 ± 3.76	”
(F-19-2)	— (G-33-4)	18.64 ± 3.99	”
(A-5-36)	— (D-11-18)	11.00 ± 1.59	”
(F-19-2)	— (D-11-18)	7.00 ± 1.99	”
(A-5-36)	— (F-19-2)	4.00 ± 2.01	Insignificant

TABLE 8

Comparative yields in cavans per hectare of different strains and of parent variety in two sets of commercial scale plantings

STRAINS	EXPERIMENTAL CULTURE	NUMBER OF PADDIES	PARALLEL CULTURE	NUMBER OF PADDIES
A – 5 – 36	75.72 ± 1.14	5	78.20 ± 1.00	3
D – 11 – 18	64.72 ± 1.11	5	56.56 ± 4.64	4
F – 19 – 2	71.72 ± 1.65	5	72.37 ± 2.67	7
G – 33 – 4	53.08 ± 3.63	5	63.82 ± 1.21	9
Control (parent variety)	54.33 ± 2.32	5	56.34 ± 3.26	8

DETERMINATION OF THE OPTIMUM AMOUNT OF FISH MEAL IN RATIONS FOR GROWING DUCKLINGS[1]

JOSÉ V. CASTILLO

WITH TWO CHARTS

There is no definite information in regard to the use of protein supplements in rations for young growing ducklings in this country. Cruz (1931) observed that the use of 20 per cent of dried shrimps did not prove materially better than the same amount of fish meal. In rations for growing chicks, 25 per cent of shrimp meal or 30 per cent of fish meal was observed to be the optimum needed (Fronda and Kabigting, 1935; Rodriguez, 1936). Shrimp meal cannot be used freely for duck feeding because of its rather high cost and because the supply is seasonal. The question may therefore be asked: Is the optimum amount of fish meal needed in the rations for growing ducklings the same as that needed for growing chicks?

Review of literature

Fronda (1928) stated that except for a few minor details, the same care should be given to ducklings as to growing chicks. When they are twenty-four hours old, they should be fed with some nourishing moist feeds.

Fronda and Kabigting (1935) reported that the best amount of shrimp meal to use for growing chicks is 25 per cent of the ration. They further found that the use of an amount below or above that increased mortality. Rodriguez (1936) reported that as the amount of "Tuna" fish meal was increased from 5 to 30 per cent, the mortality of the chicks gradually decreased. Mortality increased when more than 30 per cent "Tuna" fish meal was used in the ration.

Objects of the present work

The objects of this experiment were: (*a*) to determine the effects of various amounts of fish meal in rations for ducklings and (*b*) to determine the optimum amount of fish meal needed in a ration for growing ducklings.

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[1] Experiment Station contribution No. 1219. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

Time and place of the work

This experiment was conducted in the division of poultry husbandry, Department of Animal Husbandry, from August, 1935, to December, 1936, covering a period of seventeen months.

MATERIALS AND METHODS

A total of 368 ducklings was used in this experiment; 120 ducklings were hatched in August, 1935; 136 in February, 1936; and 112 in September, 1936. These were divided into eight lots. In the first hatch there were 15 ducklings to each lot; in the second, 17 ducklings; and in the third, 14 ducklings; a total of 46 ducklings in each lot for the three trials made.

The ducklings were brooded in a house made of light native materials. This house was 12 meters long and 1.6 meters wide, and was divided into eight compartments of approximately 1.5 meters by 1.6 meters each. Each of the eight compartments had an adjoining yard 3.6 meters long and 1.5 meters wide. For litter, lakeshore sand was placed in each of the compartments with rice straw laid on top.

The ducklings were brooded for about a month in a fireless brooder made of empty petroleum boxes. After this period, it was observed that they were big enough to stay out of the box at night. They were then allowed to move in and out of the brooder house. They began to eat the grass growing in the yards, so that in a short time the yards were almost depleted. The lack of green grass in the yards, however, did not present a problem as the ducklings were given chopped green grass regularly.

The basal ration used in each lot consisted of 3 parts rice bran and 1 part corn meal by weight. Fish meal (Lighthouse brand) in amounts varying from 5 per cent to 40 per cent was added to the basal ration to form the different rations tested. The rations given to each lot follow:

LOTS	FISH MEAL	CORN MEAL	RICE BRAN	TOTAL	NUTRITIVE RATIO [a]
	per cent	*per cent*	*per cent*	*per cent*	
I	5.00	23.75	71.25	100.00	1:5.18
II	10.00	22.50	67.50	100.00	1:4.18
III	15.00	21.25	63.75	100.00	1:3.45
IV	20.00	20.00	60.00	100.00	1:2.90
V	25.00	18.75	56.25	100.00	1:2.46
VI	30.00	17.50	52.50	100.00	1:2.11
VII	35.00	16.25	48.75	100.00	1:1.82
VIII	40.00	15.00	45.00	100.00	1:1.58

[a] Nutritive ratio was based on chemical analysis.

By computation based on the analysis of the feeds used, the amount of proteins in 100 kgm. of the different rations tested were:

LOT NUMBER	AMOUNT OF PROTEINS SUPPLIED FROM THE SUPPLEMENT	TOTAL PROTEINS IN RATIONS
	kgm.	*kgm.*
I	3.24	14.29
II	6.49	16.96
III	9.73	19.61
IV	12.98	22.28
V	16.22	24.93
VI	19.46	27.60
VII	22.71	30.27
VIII	25.96	32.93

The feed was given to the ducklings in the form of wet mash. They were fed four times a day only in amounts that they could sufficiently finish in about 15 to 20 minutes. Bamboo feeding troughs were used at first, but as the ducklings grew older, the bamboo feeding troughs were replaced with petroleum cans cut lengthwise to a height of about six centimeters. The feeding and watering troughs were washed every day.

The ducklings were leg-banded soon after they were taken from the incubator and individually weighed. Weekly weights were taken thereafter until they were twelve weeks old. Records were kept of the amount of feed consumed by each lot. Records of mortality in each lot were also kept. Observations on the vigor, feathering, and behavior of the ducklings at different ages were made.

RESULTS AND DISCUSSION

Growth of the ducklings. The weekly weight of the ducklings was used as the criterion in the determination of the effects of the rations tested on the rate of growth. These average weekly weights are given in table 1 and graphically presented in chart 1.

It may be seen in table 1 that although there was no difference in the initial weight of the ducklings in the different lots, as early as the first week variations in weight were already noticeable. From this age to twelve weeks, the end of the experiment, growth was significantly different in nearly all the lots studied.

It is interesting to note that the average initial weight was more than doubled at the age of two weeks in lots IV (20 per cent fish meal), V (25 per cent fish meal), VI (30 per cent fish meal), VII

(35 per cent fish meal), and VIII (40 per cent fish meal). These results were better than expected. Fronda and Cruz (1930) reported that the average initial weight, 37.7 grams, of their ducklings was almost doubled at the age of two weeks. In this study, the growth of the ducklings was faster by one week than was reported by Fronda and Cruz (1930).

The weights of the ducklings, as early as at the age of four weeks, showed that as the amount of fish meal in the ration was increased, there was a correspondingly regular increase in the size of the birds. When the ducklings were eight weeks old, lot VII (35 per cent fish meal) registered the highest average weight (see table 1), 931.6 ± 18.374 grams, with lot VI (30 per cent fish meal) a very close second, 927.1 ± 14.683 grams; and lot I (5 per cent fish meal), the lowest, only 287.1 ± 17.535 grams.

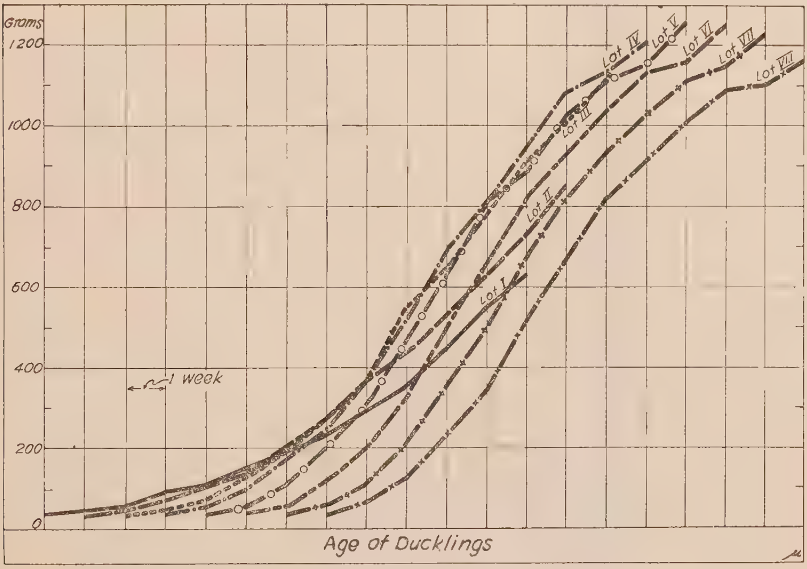

Chart 1.—Curves showing the mean weights of the ducklings in the different lots studied at different ages

From the weights of the ducklings at twelve weeks old, the different lots may be ranked as follows: lot V (25 per cent fish meal), 1255.3 ± 14.274 grams, first; lot VI (30 per cent fish meal), 1251.6 ± 12.983 grams, a very close second; lot VII (35 per cent fish meal), 1229.4 ± 17.483 grams, third; lot IV (20 per cent fish meal), 1210.2 ± 20.710 grams, fourth. Lots VIII (40 per cent fish meal), 1167.6

± 17.049 grams, III (15 per cent fish meal), 1128.3 ± 23.565 grams, II (10 per cent fish meal), 634.1 ± 45.983 grams, followed in the order given.

It may be seen from these results that as the amount of fish meal was increased from 5 to 40 per cent, there was a correspondingly regular increase in the weight or rate of gains made by the ducklings in all the lots until the fifth week, indicating the needs of the birds for rations containing as high as 35 per cent protein. From

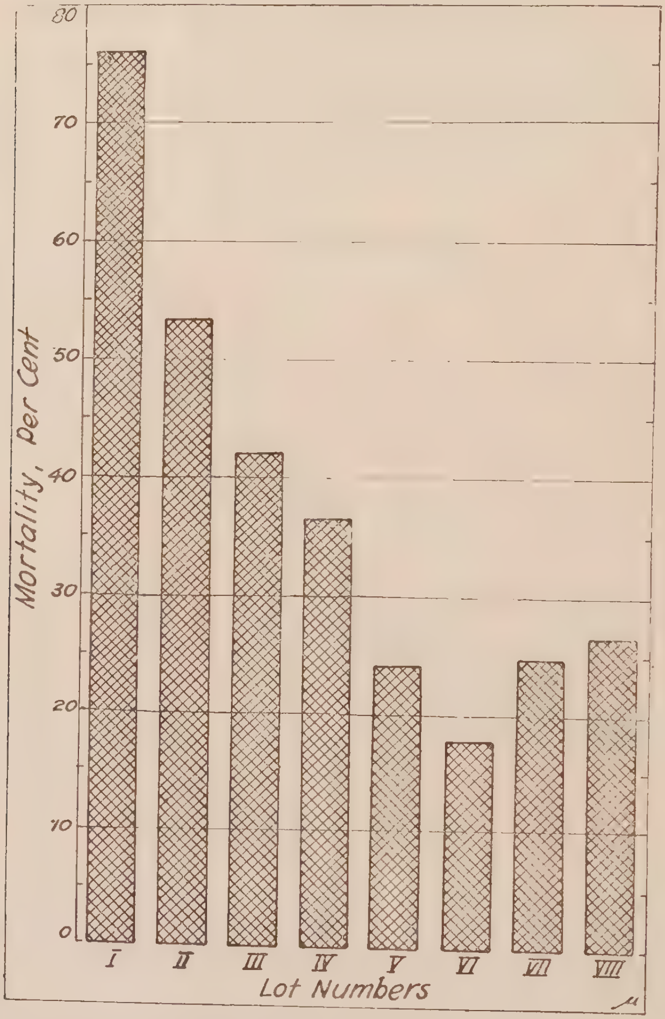

Chart 2.—A graphical presentation of the mortality of the ducklings in the different lots

that time on, however, the ducklings on rations containing over 30 per cent fish meal failed to maintain their relatively high position and thus indicated a decreasing need of the birds for the protein supplement as they grew older.

Mortality of the ducklings. The percentage of mortality of the ducklings to the end of twelve weeks is shown in table 2 and chart 2. It may be seen that lot I (5 per cent fish meal) had the highest mortality, 76.28 ± 3.708 per cent, and lot VI (30 per cent fish meal), the lowest, 17.57 ± 3.107 per cent. When the differences between the average mortality figures were compared, it was found that where the amount of the fish meal differed by 10 per cent, the differences became significant. Exceptions to these were, however, found when lot IV (20 per cent fish meal) was compared with lots VII (35 per cent fish meal) and VIII (40 per cent fish meal) and when lot VI (30 per cent fish meal) was compared with lot VIII.

From the figures given in table 2, it is evident that as the amount of fish meal was increased to 30 per cent of the ration, there was a corresponding decrease in the mortality of the ducklings; but with an increase of the fish meal beyond 30 per cent, the mortality tended to increase also. Rodriguez (1936) also reported similar findings with chicks. It is probable that the ration given to lot I (5 per cent fish meal) did not have enough of the protein supplement, but those given to lots VII (35 per cent fish meal) and VIII (40 per cent fish meal) may have had too much. Fronda, Badelles, and Padilla (1934) and Rodriguez (1936) reported that insufficient protein in the ration increased mortality, but too much was also detrimental to the chicks. Jull (1930) stated that a diet high in protein puts unnecessary burden on the kidneys of the animals.

Feed consumption and returns. Table 3, which gives the feed consumption and returns from the sale of the ducklings after deducting the cost of feeds, was constructed from tables 1 and 2. With calculations based on 100 ducklings at the start, and the average feed consumed per bird as determined in the study, it may be seen in this table that lot I (5 per cent fish meal) consumed the least amount of feed, and lot VIII (40 per cent fish meal) consumed the most. Lot I apparently had the least palatable feed and at the same time the highest mortality; out of 100 ducklings, only 24 reached the age of twelve weeks. Lot IV (20 per cent fish meal) consumed an average of 6.87 kilograms of feeds, but because only 63 ducklings reached the age of twelve weeks, the total feed consumed by the lot was only

432.81 kilograms. Lot VI (30 per cent fish meal) had 83 weanlings out of the 100 ducklings at the start, but the ducklings apparently did not relish their feed as much as the other lots, except lots I (5 per cent fish meal) and II (10 per cent fish meal).

The cost per 100 kgm. of each ration based on the prices of the feeds at the time of the study were as follows:

Lot I (5 per cent fish meal)	₱4.99
Lot II (10 per cent fish meal)	5.30
Lot III (15 per cent fish meal)	5.61
Lot IV (20 per cent fish meal)	5.93
Lot V (25 per cent fish meal)	6.24
Lot VI (30 per cent fish meal)	6.56
Lot VII (35 per cent fish meal)	6.87
Lot VIII (40 per cent fish meal)	7.18

With these figures and computations based on the total feed consumption of the lot, it may be seen in table 3 that the total cost of feeds consumed by the different lots varied from only ₱6.04 in lot I (5 per cent fish meal) to ₱34.75 in lot VIII (40 per cent fish meal). The variation in the total cost of feed consumed depends upon the cost of the ration per 100 kilograms and upon the amount of feeds consumed by the different lots. As may be expected, the bigger the amount of fish meal in the ration, the higher the cost per 100 kilograms of the ration.

With the computation based on the average weight of the ducklings at the age of twelve weeks (see table 1), the total weight of the weanlings that may be produced from 100 baby ducklings was determined. At ₱0.50 a kilogram live weight, the value of these weanlings was observed to vary from ₱7.56 in lot I to ₱51.88 in lot VI. After the cost of the feeds consumed by the different lots had been deducted from the total value of the weanlings produced, it was observed that the smallest return was obtained from lot I (5 per cent fish meal) and the biggest, from lot VI (30 per cent fish meal). The returns above the cost of feeds increased as the amount of fish meal in the ration was increased from 5 to 30 per cent. Beyond this amount, the returns above the cost of feeds decreased. It may be stated, therefore, that lot VI (30 per cent fish meal) produced the best results.

Observations on health and vigor of the ducklings

The ducklings in all the lots, except those receiving 5, 10, 15, and 40 per cent fish meal, were healthy and active. Even at the end of the experiment, the ducklings in lot I (5 per cent fish meal) remained underdeveloped when compared with those in the other lots. The ducklings receiving from 25 to 40 per cent fish meal feathered earlier than those in the other lots, so that at the age of one and a half to two months, one could easily distinguish the sexes by means of the feathers. The feathering of lots I (5 per cent fish meal), II (10 per cent fish meal), and III (15 per cent fish meal), particularly lot I, was not complete even at the end of the experiment when they were already 12 weeks old. This slowness in feathering may be attributed to the insufficiency of protein in the ration.

SUMMARY AND CONCLUSIONS

The influence of various amounts of fish meal as protein supplement in rations for growing ducklings was studied. The fish meal used in this study was the "Lighthouse" brand which contained 64.88 per cent protein. The results obtained may be summarized as follows:

1. As the amount of fish meal in the ration was increased from 5 to 30 per cent, there was a regular increase in the weight of the ducklings; but beyond 30 per cent fish meal in the ration, the weight of the ducklings decreased.
2. As the amount of fish meal was increased from 5 to 30 per cent of the ration, there was a corresponding decrease in the mortality; but with an increase beyond 30 per cent, the mortality increased.
3. The returns above feed cost were observed to be highest in lot VI (30 per cent fish meal) and lowest in lot I (5 per cent fish meal).
4. All the ducklings, except those in lots I, II, and VIII, each with a supplement of 5, 10, and 40 per cent fish meal, respectively, were apparently healthy. The ducklings in lots containing 25 to 40 per cent fish meal feathered earlier than those in the other lots.
5. Of all the lots, lot VI (30 per cent fish meal) gave the best results, indicating that 30 per cent fish meal is the optimum amount to use in rations for growing ducklings.

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TABLE 1

The average weekly weights of the ducklings in the different lots

AGES	LOT I (5% FISH MEAL)		LOT II (10% FISH MEAL)		LOT III (15% FISH MEAL)		LOT IV (20% FISH MEAL)	
	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS
	unit	*grams*	*unit*	*grams*	*unit*	*grams*	*unit*	*grams*
Day old	46	38.5 ± 0.399	46	39.3 ± 0.323	46	39.7 ± 0.293	46	39.3 ± 0.298
1 week	26	46.5 ± 0.879	38	48.7 ± 0.915	40	52.2 ± 1.046	40	57.4 ± 1.253
2 weeks	21	59.1 ± 1.563	30	67.8 ± 1.428	34	78.8 ± 1.909	34	100.0 ± 3.920
3 weeks	16	88.8 ± 3.496	28	106.5 ± 3.534	31	128.5 ± 5.082	30	173.0 ± 8.120
4 weeks	15	112.6 ± 5.783	28	142.8 ± 6.183	31	190.8 ± 7.542	30	249.2 ± 10.631
5 weeks	14	151.6 ± 9.607	26	195.2 ± 8.686	30	271.7 ± 10.144	29	364.6 ± 14.706
6 weeks	14	183.6 ± 9.034	24	275.6 ± 11.155	30	367.2 ± 15.251	29	525.0 ± 16.034
7 weeks	14	231.4 ± 12.783	23	365.2 ± 15.212	29	547.8 ± 15.623	29	689.1 ± 21.124
8 weeks	14	287.1 ± 17.535	23	437.6 ± 17.692	29	658.1 ± 19.961	29	809.5 ± 20.985
9 weeks	14	352.1 ± 19.862	22	536.4 ± 22.436	29	787.6 ± 23.725	29	942.8 ± 21.008
10 weeks	12	445.0 ± 35.233	22	637.7 ± 25.786	29	911.7 ± 26.557	29	1081.6 ± 22.623
11 weeks	11	545.9 ± 40.405	22	731.8 ± 28.911	27	1012.8 ± 24.993	29	1137.2 ± 18.722
12 weeks	11	634.1 ± 45.893	22	855.9 ± 31.826	27	1128.3 ± 23.565	29	1210.2 ± 20.710

TABLE 1 (continued)

AGES	LOT V (25% FISH MEAL)		LOT VI (30% FISH MEAL)		LOT VII (35% FISH MEAL)		LOT VIII (40% FISH MEAL)	
	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS	NO. OF DUCKLINGS	AVERAGE WEIGHTS
	unit	*grams*	*unit*	*grams*	*unit*	*grams*	*unit*	*grams*
Day old	46	39.8 ± 0.311	46	38.9 ± 0.308	46	38.7 ± 0.343	46	38.9 ± 0.367
1 week	41	58.4 ± 1.247	38	59.5 ± 1.272	40	60.5 ± 0.510	39	63.2 ± 1.649
2 weeks	36	111.0 ± 3.660	38	120.3 ± 3.687	36	117.2 ± 3.758	37	131.6 ± 4.303
3 weeks	35	202.9 ± 8.256	38	200.9 ± 6.190	36	209.6 ± 8.065	37	229.7 ± 7.890
4 weeks	35	313.7 ± 11.891	38	328.2 ± 8.116	36	349.9 ± 11.682	37	355.0 ± 10.872
5 weeks	35	470.6 ± 12.307	38	501.8 ± 11.127	36	502.2 ± 13.857	37	519.6 ± 13.723
6 weeks	35	626.1 ± 12.564	38	659.7 ± 14.695	36	676.7 ± 13.854	37	675.3 ± 14.839
7 weeks	35	809.6 ± 15.183	38	824.2 ± 14.902	36	821.4 ± 17.145	37	827.2 ± 16.326
8 weeks	35	898.9 ± 13.625	38	927.1 ± 14.683	36	931.6 ± 18.374	37	915.5 ± 16.844
9 weeks	35	1025.3 ± 14.656	38	1042.1 ± 16.089	36	1028.9 ± 19.297	37	1019.1 ± 16.879
10 weeks	35	1117.3 ± 16.071	38	1138.2 ± 15.283	36	1115.0 ± 19.574	37	1093.1 ± 19.050
11 weeks	35	1151.0 ± 16.138	38	1160.0 ± 15.287	34	1153.5 ± 16.318	34	1102.6 ± 15.129
12 weeks	35	1255.3 ± 14.274	38	1251.6 ± 12.983	34	1229.4 ± 17.483	34	1167.6 ± 17.049

TABLE 2

Mortality of ducklings

LOT NO.	FISH MEAL IN RATION	TRIALS			AVERAGE
		1	2	3	
	per cent				
I	5	66.67	76.47	85.71	76.28 ± 3.708
II	10	53.33	35.29	71.43	53.35 ± 7.036
III	15	46.67	29.41	50.00	42.03 ± 4.304
IV	20	40.00	41.18	28.57	36.58 ± 2.712
V	25	33.33	17.65	21.43	24.14 ± 3.186
VI	30	26.67	11.76	14.29	17.57 ± 3.107
VII	35	26.67	11.76	35.71	24.71 ± 4.709
VIII	40	20.00	23.53	35.71	26.41 ± 3.209

TABLE 3

Feed consumption and returns based upon 100 ducklings at the start

LOT. NO.	FISH MEAL IN RATION	NO. OF DUCKLINGS AT THE START	NO. OF DUCKLINGS AT THE END	AVERAGE FEED PER BIRD	TOTAL FEED CONSUMED BY LOT	COST OF FEED PER 100 KGM.	TOTAL COST OF FEED CONSUMED BY LOT	AVERAGE WEIGHT OF EACH WEANLING	TOTAL WEIGHT OF WEANLINGS IN LOT	TOTAL VALUE OF WEANLINGS IN LOT	RETURNS ABOVE COST OF FEED
	per cent			*kgm.*	*kgm.*	*pesos*	*pesos*	*kgm.*	*kgm.*	*pesos*	*pesos*
I	5	100	24	5.04	120.96	4.99	6.04	0.63	15.12	7.56	1.52
II	10	100	47	5.16	242.52	5.30	12.88	0.86	40.42	20.21	7.33
III	15	100	58	6.39	370.62	5.61	20.79	1.13	65.54	32.77	11.98
IV	20	100	63	6.87	432.81	5.93	25.67	1.21	76.23	38.12	12.45
V	25	100	76	6.14	466.64	6.24	29.12	1.25	95.00	47.50	18.38
VI	30	100	83	5.67	470.61	6.56	30.87	1.25	103.75	51.83	21.01
VII	35	100	75	6.27	470.25	6.87	32.31	1.23	92.25	46.13	13.82
VIII	40	100	74	6.54	483.96	7.18	34.75	1.17	86.58	43.29	8.54

COMPARATIVE EFFECTS OF AMMONIUM SULFATE AND LEGUMES ON THE YIELD OF SUGAR CANE[1]

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WITH THREE TEXT FIGURES

In most cane growing countries the plant food lacking in the soil is supplied by the application of commercial fertilizers. In the Philippines, ammonium sulfate is the fertilizer commonly applied. In some countries legumes in the form of green manure have been found to increase the yield of sugar cane. Since the application of commercial fertilizers is quite expensive and legumes could be grown relatively cheaply in fallow cane land, it should be of interest to find out the comparative effects of ammonium sulfate and legumes as green manure on the yield of sugar cane.

Review of literature

A survey of the available literature on the subject shows that ammonium sulfate very definitely improves the yield of sugar cane. However, the rate of application varies in different countries. Lee (1929) reported that in Java 524 kilograms of ammonium sulfate per hectare is the amount commonly applied. In the Philippines, Walker (1926) reported that 50 to 100 kilograms of nitrogen, or 250 to 500 kilograms of ammonium sulfate, per hectare give the best results.

As to the effects of green manure on sugar cane production, one of the earliest records is one published in Jamaica in 1902. In this paper, local planters were urged to use green manure to maintain the fertility of Jamaican sugar-cane lands.

Knight (1911) found that in Bombay Presidency, India, *Crotalaria juncea* was more effective and less expensive than stable manure as a fertilizer for sugar cane.

Van Deventer and Houtman (1911) found that in Java green manures gave excellent results with sugar cane, particularly where heavy applications of ammonium sulfate alone had little or no effect on the growth of the plant.

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Wilcox and Kelly (1914) reported that in the Hawaiian Islands one of the Crotalarias (*C. saltiana*) was found to be a very effective green manure in several plantations, and fields which had been the poorest gave the highest yields, even without using excessive amounts of commercial fertilizers.

In Louisiana, Taggart (1922, 1923) reported that sweet clover increased the yield of cane in tons per hectare from 25 (check) to 35 or 40 tons, depending on the date of plowing under the green manure crop. It was also reported in Louisiana (1928-1929) that "fertilizer tests with sugar cane continued to emphasize that legumes properly used are quite essential to soil fertility." It was found that with green manuring the application of nitrogenous fertilizers to plant cane was not profitable, but on ratoon cane it was usually profitable. It was found that where the "green manure" was cut for hay and removed from the field, instead of being plowed under, the yield of the cane following was less than where the plants were plowed under.

In the Philippines, Santos (1925), experimenting on green manuring of sugar cane, reported that experiments with peanuts, mungo, Mauritius beans, and velvet beans were conducted and that all of the experiments gave satisfactory results. He expressed the opinion that green manure is a fertilizer well adapted to a hot climate and to good soils such as that obtaining in the Pampanga district, but for poor soils it is of little or no value. Santos found the use of green manure most economical; it cost only ₱28.91 a hectare.

Experimenting with green manure, Pritchett (1926) found that in the Talisay-Silay district of Occidental Negros legumes plus lime was the best fertilizer; lime alone, second; and legumes alone, the poorest.

Walker (1926) stated that while green manuring had long been considered a good agricultural practice, it was not financially profitable to the cane planter unless it furnished nitrogen cheaper than by direct purchase. According to him, the Hawaiian Sugar Planter's Experiment Station, after an experiment with lupines (*Lupinus albus*), a very quick-growing legume, which failed to show any gain over the check plot, took the following stand: "The station does not advocate the use of lupines for green manuring purposes. We believe it is more profitable to allow natural growth to take place on the fallow fields and to pasture stock on them. This entails no expense and furnishes feed for cattle and gives some benefit from the manure produced."

More recently Calma and Andam (1935) found that control plots and those fertilized with ammonium sulfate gave significantly higher yields of cane and sugar than those green manured with cowpea, soybean, and mungo. The results indicated also that the application of ammonium sulfate had an immediate beneficial effect on the yield of sugar cane, but none on the yield of the succeeding ratoon crop.

Object of the present study

The object of the present work was to determine the comparative effects of ammonium sulfate fertilizer and three different legumes used as green manure on the yields of cane, sugar, and sugar per ton of sugar cane.

Time and place of the work

The work was carried on from June, 1935, to March, 1937, in the Experiment Station of the College of Agriculture.

MATERIALS AND METHODS

Field and variety of sugar cane used. The soil is clay loam. The field used was divided into fifteen plots of 510 sq. m. each which were treated as follows:

(1) Three plots were fertilized with ammonium sulfate containing 20 per cent nitrogen.

(2) Three plots were green-manured with New Era cowpea, *Vigna sinensis* (Linn.) Savi.

(3) Three plots were green-manured with Ami soybean, *Glycine max* (Linn.) Merr.

(4) Three plots were green-manured with mungo, *Phaseolus aureus* (Roxb.)

(5) Three plots were given no treatment and served as control.

The cane variety used was P. S. A. 14.

Preparation of the land and planting of legumes. The land was thoroughly prepared by plowing and harrowing several times before the legumes were broadcasted on the plots. The different legumes were each sown at the rate of three liters per plot, or 58.82 liters per hectare. The plants were plowed under at the full blooming stage, when they were supposed to have available the greatest amount of nitrogen. According to Pieters (1927), it was found that, with crimson clover, the greatest amount of nitrogen per acre was found at the time of full bloom.

Observations on green manure culture. The legumes were closely observed in the field. The number of days from planting to germination and from planting to flowering was recorded. The relative stand of the different legumes, their susceptibility to pests and diseases, and their behavior were also recorded.

Fertilization. The ammonium sulfate fertilizer used in this experiment was distributed in the hills in the furrows just before planting at the rate of 15 grams per hill, or 300 kilograms per hectare.

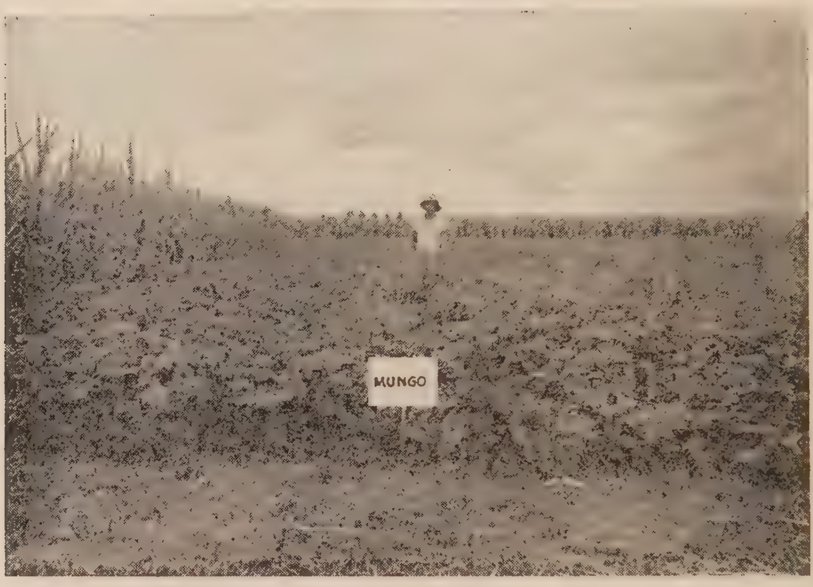

Fig. 1.—Showing a plot planted with mungo. Note the good stand of plants and vigorous growth of the legumes. The weeds are practically suppressed by the legumes. The photograph was taken 47 days after planting.

Planting. Top seed pieces of P. S. A. 14 were used and were prepared in the usual manner. The distance between the furrows was 100 cm. and between hills in the furrow, 50 cm. One seed piece was planted to a hill. The hills were arranged in quincunx.

Harvesting and determination of yields. The canes were harested on January, 1937, or about 12 months after planting. The yields of the different plots were weighed and recorded separately.

The crusher juice of the canes from each plot was analyzed and the degree Brix and percentage of polarization were determined with the help of Dr. Getulio Guanzon, of the Department of Agricultural Chemistry. From these data, the apparent purity, piculs sugar per ton cane, and piculs sugar per hectare from each treatment were determined by the use of Methods of Chemical Control for Cane Sugar Factories, published in 1931 by the Association of Hawaiian Sugar Technologists.

RESULTS AND DISCUSSION

The results of this study are presented in tables 1-2 and figures 1-3.

Observations on green manure cultures. All the three legumes germinated in two to three days. The number of days from planting to flowering was as follows: mungo, 44 days; soybean, 48 days; and cowpea, 58 days. A knowledge of the length of time it will take a legume to flower is important as this is a guide in selecting the green manure crop suitable to the time available for green manuring. The results show that in two to three months all the three legumes were ready for green manuring.

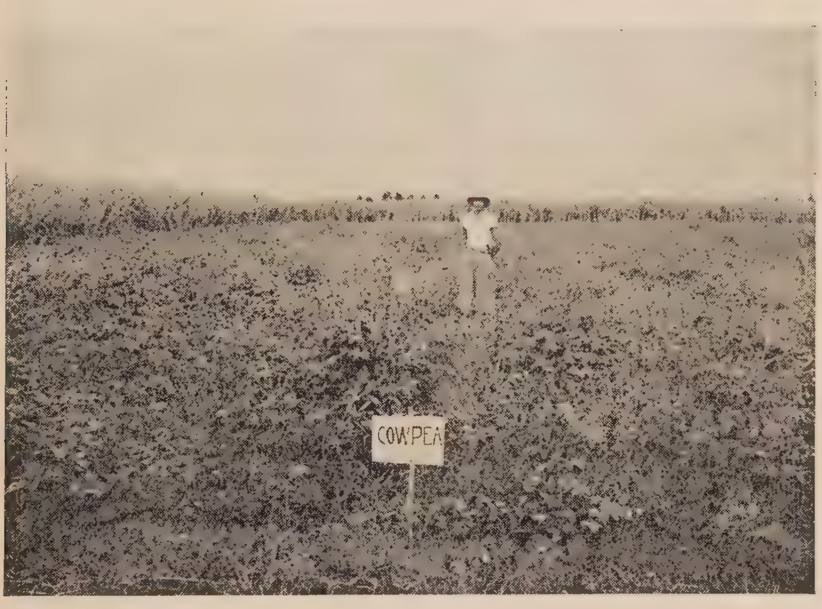

Fig 2.—Showing a plot planted with cowpea. Note the poor stand of plants and the presence of many weeds in the vacant spaces. At the extreme left is shown the thick growth of mungo of an adjacent plot. The photograph was taken 47 days after planting.

It will be seen in figures 1 to 3 that mungo had the best stand of plants in the field. Most of the mungo seeds had germinated and the plants were the most vigorous. It will be seen in figure 1 that the weeds were practically suppressed by the luxuriant growth of mungo plants. Only leaf rust was observed on some of the plants, but it apparently did not affect their normal growth.

Figures 2 and 3 show the relatively poor stands of the cowpea and soybean cultures, respectively. Evidently, these two legumes require more careful planting as very likely most of the seeds failed to germinate because they were either left exposed on the surface of the soil or only slightly covered by the harrow. According to Professor Vicente B. Aragon, of the Department of Agronomy, in order to obtain a high percentage of germination with soybean, the seed must be well covered with soil. It will be seen in figures 2 and 3 that there was an abundance of weeds growing in the cowpea and soybean lots. It was also observed that the cowpea plants were badly attacked by the pest *Agromyza phaseoli* (Coquillett), a dipteron that mined the leaves and the stem of the plant. The maggot caused rotting of the stem, which resulted in the death or stunted growth of the plant as if it had been attacked by mosaic disease.

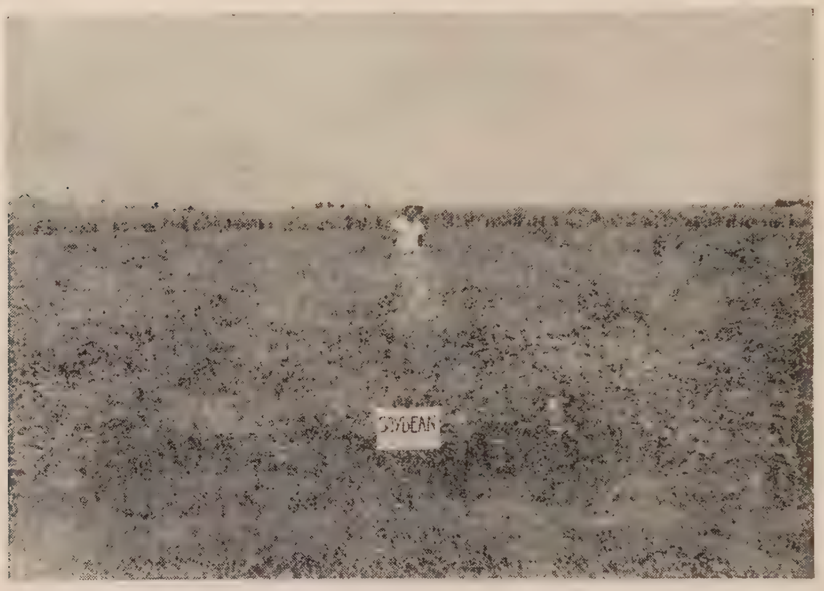

Fig. 3.—Showing a plot planted with soybean. Note the poor stand of plants and the presence of weeds in the vacant spaces. The photograph was taken 47 days after planting.

When turned under with a native plow, it was found that about five per cent of the tops of the soybean and mungo plants were not covered. About 10 per cent of those of cowpea was not covered. A greater portion of the tops of cowpea was not covered because this legume produced long vines. It took about 20 days for the different green manures to decay completely.

As a whole, the results show that all the three legumes were ready to be turned under in 45 to 60 days. Mungo had the best stand and growth and proved to be the best of the three green manure crops tried.

Comparative germination of sugar cane under the different treatments. Table 1 shows the percentage of germination under the different treatments. It will be seen in this table that the average percentage of germination under the different treatments ranged from 77.28 to 85.90 per cent. The plots green-manured with mungo had the lowest percentage of germination, and those green-manured with cowpea, the highest. That the control gave a higher percentage of germination than the plots green-manured with mungo can not be attributed to the incomplete decomposition of the green manure, for the vegetation was thoroughly decomposed when the seed pieces of sugar cane were planted. Furthermore, in a study on the effects of different green manures at different stages of decomposition upon germination and development of plants of different kinds of seeds conducted by the writer, he found that oily seeds were readily damaged, while starchy seeds as well as seed pieces of sugar cane were not affected. Pieters (1927) reported similar results.

As a whole, the results show that with the exception of the mungo lot, all the other treatments gave practically the same percentage of germination as the control.

Comparative yields of cane, sugar, and piculs sugar per ton cane of the different treatments. The comparative yields of cane and sugar per hectare and sugar per ton cane of the different treatments are shown in table 2. It will be seen in this table that the average yield of cane varied from 46.81 ± 1.88 to 81.98 ± 7.36 tons per hectare, with the plots fertilized with ammonium sulfate having the highest yield and those green-manured with mungo, the lowest.

That the plots green-manured with mungo gave the lowest yield of cane may be due to the fact that these plots gave the lowest percentage of germination. The superiority of ammonium sulfate to the other treatments may be due to its immediate beneficial effects.

It will be seen in table 2 that the other green-manured plots gave lower yields of cane than either the control plots or those fertilized with ammonium sulfate. However, there was an insignificant difference between the yields of the control plots and those of the green-manured plots. There was also an insignificant difference between the yield of cane of the control plots and those fertilized with ammonium sulfate. Likewise, the differences in the yield of cane between the different green-manured plots were insignificant.

As a whole, the results indicate that ammonium sulfate had a beneficial effect upon the yield of sugar cane, whereas green manuring had a harmful effect upon the crop. Pieters (1927) reported that when non-legumes are turned under, the nitrogen they have previously taken from the soil is merely transformed from organic to nitrate nitrogen. In the course of these transformations, nitrogen may be locked up in the bodies of microörganisms and may be made temporarily unavailable to crop plants. Furthermore, the same author reported that not all of the nitrogen in green manure becomes available to the succeeding crop. This might have been the case in the present study.

The results suggest that in order to increase significantly the yield of cane and sugar, an application of ammonium sulfate in amounts greater than 300 kilograms per hectare should be made in the College Experiment Station soils.

It will be seen in table 2 that the plots fertilized with ammonium sulfate gave the highest yields of sugar per hectare and those green-manured with mungo, the lowest. There was a significant difference of 53.88 ± 15.35 piculs sugar per hectare between these two treatments. It may also be seen in the table that the differences in the yield of sugar between the plots fertilized with ammonium sulfate and the other plots green-manured with legumes other than mungo were insignificant. Likewise, the differences in the yield of sugar between the other treatments were insignificant.

Table 2 shows that the average yield of sugar per ton cane varied from 1.83 ± 0.03 to 2.13 ± 0.07, with the cane in plots green-manured with soybean having the highest and those fertilized with ammonium sulfate, the lowest. As a whole, the results in table 2 show that the application of ammonium sulfate fertilizer reduced the yield of sugar per ton cane. Green manuring on the other hand, did not affect the yield of sugar per ton cane.

SUMMARY OF RESULTS

An attempt was made to study the comparative effects of ammonium sulfate and different legumes used as green manure upon the yield of sugar cane. The results obtained from this study may be summarized as follows:

1. The three different legumes germinated in 2 to 3 days after planting. It took 44 days for mungo to reach the flowering stage, 48 days for Ami soybean, and 58 days for New Era cowpea. Mungo was the best legume for green manuring for it gave the best stand of plants and the thickest growth.

2. Ammonium sulfate had a beneficial effect upon the yield of sugar cane. An amount greater than 300 kilograms per hectare should be applied under Los Baños conditions in order to obtain more significant results.

3. Green manuring lowered the yield of sugar cane.

4. The application of ammonium sulfate decreased the yield of sugar per ton cane, whereas green manuring did not have any effect upon the yield of sugar per ton cane.

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TABLE 1

Percentage of germination under the different treatments

TREATMENTS	GERMINATION			
	Plot 1	Plot 2	Plot 3	Average
	per cent	*per cent*	*per cent*	*per cent*
Control	80.73	89.08	78.68	82.83
Ammonium sulfate	89.56	86.94	79.67	85.39
Cowpea	91.08	92.69	73.94	85.90
Soybean	90.90	81.70	78.97	83.86
Mungo	85.60	72.26	73.98	77.28

TABLE 2

Comparative average yields of cane, sugar per hectare, and piculs sugar per ton cane under the different treatments

TREATMENTS	AVERAGE YIELD OF CANE PER HECTARE		AVERAGE YIELD OF SUGAR PER HECTARE		AVERAGE YIELD OF SUGAR PER TON CANE	
	Yield	Difference	Yield	Difference	Yield	Difference
	tons	*tons*	*piculs*	*piculs*	*piculs*	*piculs*
Control	60.29 ± 6.59		128.42 ± 13.73		2.12 ± 0.02	
Ammonium sulfate	81.98 ± 7.36	21.69 ± 9.88 (Insignificant)	151.26 ± 14.98	22.84 ± 20.32 (Insignificant)	1.83 ± 0.03	— 0.29 ± 0.03 (Significant)
Cowpea	54.23 ± 3.43	— 6.06 ± 7.43 (Insignificant)	105.72 ± 6.19	— 22.70 ± 15.07 (Insignificant)	1.95 ± 0.01	— 0.17 ± 0.02 (Significant)
Soybean	52.43 ± 3.29	— 7.86 ± 7.36 (Insignificant)	111.26 ± 4.76	— 17.16 ± 14.53 (Insignificant)	2.13 ± 0.07	0.01 ± 0.07 (Insignificant)
Mungo	46.81 ± 1.88	— 13.48 ± 5.85 (Insignificant)	97.38 ± 3.36	— 31.04 ± 14.14 (Insignificant)	2.08 ± 0.01	— 0.04 ± 0.02 (Insignificant)
Ammonium sulfate [a]	81.98 ± 7.36		151.26 ± 14.98		1.83 ± 0.03	
Cowpea	54.23 ± 3.43	— 27.75 ± 8.06 (Significant)	105.72 ± 6.19	— 45.54 ± 16.21 (Insignificant)	1.95 ± 0.01	0.12 ± 0.03 (Significant)
Soybean	52.43 ± 3.29	— 29.55 ± 8.12 (Significant)	111.26 ± 4.76	— 40.00 ± 15.72 (Insignificant)	2.13 ± 0.07	0.30 ± 0.07 (Significant)
Mungo	46.81 ± 1.88	— 35.17 ± 7.60 (Significant)	97.38 ± 3.36	— 53.88 ± 15.35 (Significant)	2.08 ± 0.01	0.25 ± 0.03 (Significant)
Cowpea [b]	54.23 ± 3.43		105.72 ± 6.19		1.95 ± 0.01	
Soybean	52.43 ± 3.29	— 1.80 ± 4.75 (Insignificant)	111.26 ± 4.76	5.54 ± 7.81 (Insignificant)	2.13 ± 0.07	0.18 ± 0.07 (Insignificant)
Mungo	46.81 ± 1.88	— 7.42 ± 3.79 (Insignificant)	97.38 ± 3.36	— 8.34 ± 7.05 (Insignificant)	2.08 ± 0.01	0.13 ± 0.01 (Significant)
Soybean [c]	52.43 ± 3.29		111.26 ± 4.76		2.13 ± 0.01	
Mungo	46.81 ± 1.88	— 5.62 ± 3.91 (Insignificant)	97.38 ± 3.36	— 13.88 ± 5.83 (Insignificant)	2.08 ± 0.01	— 0.05 ± 0.07 (Insignificant)

[a] Ammonium sulfate was used as the basis for comparison.
[b] Cowpea was used as the basis for comparison.
[c] Soybean was used as the basis for comparison.

THE EFFECTS OF SOME INORGANIC AND ORGANIC SALTS ON THE HYDROLYSIS OF SUCROSE BY INVERTASE[1]

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Sugar cane juices contain substances other than sucrose that rotate the plane of polarized light and therefore affect the reading in the saccharimeter. Some of these substances increase the reading for sucrose, while others have the opposite effect. It is because of these substances that direct polarization can not give the true sucrose value. To secure a more precise control of the process of manufacture or to calculate the share of the individual farmer in the sugar made from his canes it has been found desirable and more accurate to use the figures obtained by double polarization. These figures give the true amount of sucrose.

Of the various methods of determining sucrose, the invertase method is conceded to be the most accurate. This method, however, assumes the complete absence of impurities or the presence only of traces. Whether this method will work in the presence of appreciable amount of impurities in ordinary sugar solutions or not is not known, hence, the present study.

Review of literature

So far, not much experimental work has been done on the effect of some added impurities upon the sucrose in pure and impure sugar solutions by the invertase method. No report of work on the subject done in the Philippines was found in available literature. A brief review of available work done abroad is here given.

Beatty (1917) recommended the presence of low concentration of acid in the medium in order to get the maximum activity of the invertase. He found that high acid concentration and the presence of alkali in the medium prevent the activity of the enzyme. He also found that calcium chloride weakens the enzymes and that at high concentrations the activity is totally inhibited. He advanced the idea that this is due to an alteration in the electric charge.

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[1] Experiment Station contribution No. 1221.

Neuschlosz (1920) worked on the cleavage of sucrose by invertase. He found that the chlorides of the alkali and the alkaline earth exert an inhibitory effect on the action of enzyme on the hydrolysis of the sugar. He concluded that the inhibitory effect increases somewhat with increase in concentration of the salt, and that it has a direct relation with the valence of the cation used. Thus salts of calcium, strontium, and magnesium are decidedly more active than those of sodium and potassium.

Fales and Nelson (1915), working on hydrolysis by the invertase method, concluded that sodium chloride effects a decrease in the activity of the invertase even if the H-ion is carefully adjusted to pH 4.5.

MATERIALS AND METHODS

Cane wax. This was prepared from air-dried filter press cake and scrapped sugar-cane rind in accordance with the method of extraction and purification of cane wax used by Guanzon (1927).

Purified sugar. This was prepared from refined sugar in accordance with the method given by the International Commission for Unifying Methods of Sugar Analysis, cited by Browne (1912).

Centrifugal sugar. Ordinary centrifugal sugar was used. The sugar was dried over sulfuric acid in a desiccator for sometime before being used.

Molasses. The final molasses sample of the 1934-35 cane crop of the U. P. Sugar Mill was used.

Sugar solutions from purified sugar, centrifugal sugar, and molasses were prepared.

The solids in sugar were determined by drying and that in molasses, by the Brix spindle.

The sucrose of the sample was determined both in the absence and in the presence of added impurities in accordance with the methods of Paine and Balch (1925) and of Bermejo and King (1929). The sucrose was calculated according to the following formula:

$$\frac{100 \times (D-I)}{F \times \frac{1}{2}t}, \text{ where}$$

D = direct reading
I = invert reading
t = temperature of observation
F = interpolated Hertzfeld's factor

RESULTS AND DISCUSSION

Table 1 gives the summary of the results of at least three concordant trials for every concentration of the different salts.

Effect of sodium chloride

It may be seen in table 1 that the maximum percentage of sucrose was obtained in purified sugar solution at 3.5 hours of standing in the presence of invertase. A slight decrease in the percentage of sucrose was obtained at longer periods of standing. From these results, therefore, 3.5 hours of standing seemed to be the shortest time in which complete inversion could be obtained. These results are in agreement with the findings of Bermejo and King (1929) and of Paine and Balch (1925).

By adding one gram of sodium chloride to every 100 ml. of the solution to be inverted, maximum inversion took place in 3.5 hours. The sucrose value, however, was lower by 0.81 per cent of the figure obtained in the control. A slight reduction occurred by prolonging the time. By increasing the amount of NaCl (3 and 5 grams) still lower figures were obtained. The harmful effect of NaCl was markedly shown at a concentration of 5 grams per 100 ml. of the solution. It is very probable that the activity of the enzyme was partly suppressed, as at 2.5 and at 3.5 hours of standing plus invert readings were obtained. Its activity was not completely suppressed, as at 4.5, 5.5, and 6.5 hours standing negative invert readings were obtained. It may be assumed that the active principle in the invertase was reduced to such an extent that the residual principle was not sufficient to complete the hydrolysis of sucrose in the solution.

When a solution of centrifugal sugar was used, the same trend of results was observed. In the absence of any added salt, the average maximum percentage of sucrose (97.06 per cent) was obtained after 4.5 hours of inversion. The delay might be due to the presence of some impurities originally present in the sugar sample.

These results are in accord with the findings of Neuschlosz (1920) that the chlorides of alkali exert an inhibitory effect on the hydrolysis of sucrose. No mention, however, was made of the method used in Neuschlosz' work. These findings, as well as those of Neuschlosz, seem to contradict the results of Jackson and Gillis (1920), who found that sodium chloride increases the specific rotation of invert sugar. The inverting agent used by them was hydrochloric acid. If the specific rotation of invert sugar solution is increased, a higher percentage of sucrose is to be expected. On the contrary, it has been found that the percentages of sucrose obtained were lowered by the introduction of sodium chloride into the solution.

Effect of ammonium phosphate

The amount of salt added ranged from one to five grams per 100 ml. of the solution to be inverted. It is seen in table 1 that with the concentrations of the salts tried no effect on the hydrolysis by invertase was observed. Even with the addition of five grams of the salt, the difference from the control was only very slight.

Effect of ferric sulfate

The average maximum percentages of sucrose in the control were 99.74 for purified sugar solution and 97.06 for centrifugal sugar solution. These figures were obtained at 3.5 hours of inversion.

A sudden drop in the percentages of sucrose was observed when varying amounts of ferric sulfate were added. In trial tests using one gram of the salt, an almost complete suppression of the inverting power of the enzyme was noted. Even with the addition of such low concentration of impurity as 0.5 gram per 100 ml. the sucrose figure dropped from 99.74 per cent in the control to 38.23 per cent in purified sugar solution and 97.06 per cent to 38.25 per cent in ordinary centrifugal sugar solution.

The observed pronounced inhibitory effect of ferric sulfate on the hydrolysis by invertase of sucrose in purified and ordinary centrifugal sugar solutions may be due to the reduction of the active principle of the enzyme, as in the case of sodium chloride. These results are in accord with the findings of Deerr (1910a) and Floyd (1931). These investigators used hydrochloric acid as an inverting agent. Deerr (1910a) found that a 0.2 N of the sulfates of alkali and alkaline earth metals materially retarded the rate of inversion, and the degree of retardation was directly proportional to the amount of salt added. Floyd (1931) also found the same effect. He even noticed negative effect in sucrose inversion.

Effect of magnesium sulfate

It is readily seen in table 1 that magnesium sulfate has very little effect on the hydrolysis of sucrose by invertase. As a matter of fact, the usual weight of the salt taken was not followed since the addition of one gram per 100 ml. of solution produced no effect. The difference in the percentages of sucrose in the control and in the experiments when varying amounts of magnesium sulfate were added is slight.

Effect of potassium chloride

It may be seen that potassium chloride produced a lowering in the percentages of sucrose in the control from 99.88 to 98.14 when one gram of the salt was added to 100 ml. of the purified sugar solution to be inverted. Upon the addition of three grams of the salt, the maximum percentage of sucrose obtained was 92.86. When 6 grams of the salt were added, the percentage of sucrose obtained for the same length of time was 89.86. These data show that as the concentration of the salt added becomes higher, the inhibitory effect of the salt on the inversion of sucrose becomes greater. These results are in accord with the findings of Washburn (1931), which showed that potassium chloride decreased the specific rotation of sucrose. These data, as well as the findings of Washburn, seem to contradict the findings of Jackson and Gillis. A similar trend of results was obtained when centrifugal sugar and final molasses were used instead of purified sugar solution.

Effect of calcium chloride

In the absence of any added salt, the average maximum percentage of sucrose obtained was 99.75. On the addition of one gram of calcium chloride per 100 ml. of the purified sugar solution plus readings were still obtained. These indicate that the salt almost completely suppressed the inverting power of the enzyme. When the concentration of the salt was increased, the negative effect became more pronounced, that is, the purity was reduced to 0.74 when 3 grams of the salt were added and to 0.56 when 5 grams were added.

Identical results were obtained when molasses and centrifugal sugar solutions were used for that of purified sugar solution. Jackson and Gillis (1920) found that calcium chloride increases the specific rotation of invert sugar obtained from the hydrolysis of sucrose using hydrochloric acid as an inverting agent. From their findings higher percentages of sucrose would be expected in solutions in which this salt was added. But in the present study the reverse was true. Our results confirm that of the findings of Beatty (1917) who found that calcium chloride was capable of weakening the inverting power of invertase.

Effect of potassium nitrate

The inhibitory effect of potassium nitrate on the hydrolysis by invertase of sucrose in purified and centrifugal sugar solutions and in molasses seemed to become more pronounced as the amount of the salt added increased, as shown in table 1. It is also seen that there was a destruction of the invert sugar formed, as shown by the sudden drop in the percentages of sucrose after the maximum percentage of sucrose was reached. This was especially noticeable with the addition of six grams of salt.

Effect of ammonium carbonate

Ammonium carbonate, like calcium chloride, almost completely destroyed the inverting power of the enzyme. The inhibitory effect of ammonium carbonate was so pronounced that even at a very low concentration, as one gram per 100 ml., the average percentage of sucrose obtained was only 1.36 compared with 99.72 in the control for the same length of time allowed for inversion. All the invert readings obtained in the different concentrations of ammonium carbonate tried were positive.

Effect of cane wax

It is readily seen from table 1 that cane wax does not affect the inverting power of invertase in either purified or centrifugal sugar solutions. Complete hydrolysis can, therefore, be effected even in the presence of any sugar-cane wax with the solution to be inverted. This result seems to be in accord with the findings of Hudson and Paine (1910) that the presence of starches, dextrins, maltose, ketose, pentosans, and glycerides have no effect on the enzyme invertase.

SUMMARY

1. Ammonium phosphate, magnesium sulfate, and sugar-cane wax were practically without any appreciable effect on the activity of the invertase.

2. Potassium nitrate, potassium chloride, sodium chloride, ferric sulfate, ammonium carbonate, and calcium chloride retarded the catalytic inversion of sucrose by invertase, and the degree of retardation was least with potassium nitrate and became greater in the order in which they are listed above.

3. Potassium nitrate and potassium chloride destroyed the invert sugar produced from the hydrolysis of sucrose with prolonged contact, the reduction being more pronounced at the higher concentration of the salt.

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TABLE 1

Summary of the averages of the effects of impurities on the hydrolysis of sucrose by invertase

SAMPLE	IMPURITY	CONCENTRATION gm./100 ml.	T_1 = 2.5 HR. Per cent sucrose	T_2 = 3.5 HR. Per cent sucrose	T_3 = 4.5 HR. Per cent sucrose	T_4 = 5.5 HR. Per cent sucrose	T_5 = 6.5 HR. Per cent sucrose
Purified sugar	Sodium chloride (NaCl)	Control	98.331	99.804	99.608	—	—
		1	92.714	97.997	97.721	—	—
		3	81.861	89.112	93.435	95.140	95.140
		5	49.598	63.319	80.537	84.905	84.716
	Ammonium phosphate $(NH_4)_3PO_4$	Control	98.081	99.731	99.731	—	—
		1	99.339	99.339	98.468	98.468	—
		3	99.141	99.336	98.468	98.468	—
		5	99.090	99.454	99.201	99.201	—
	Ferric sulfate $(Fe_2(SO_4)_3)$	Control	88.081	99.804	99.804	—	—
		0.5	38.304	38.229	38.229	—	—
		7.5	32.011	32.011	32.011	—	—
		1.25	30.753	30.753	—	—	—
	Magnesium sulfate $(MgSO_4)$	Control	98.394	99.598	99.210	—	—
		2	97.072	97.958	98.399	98.012	—
		4	97.952	98.824	98.503	98.147	—
		6	98.388	99.446	99.314	98.767	—
	Potassium chloride (KCl)	Control	98.726	99.875	99.875	—	—
		1	97.704	98.143	97.896	—	—
		3	92.511	92.055	92.864	92.424	—
		5	86.809	88.809	89.862	91.437	90.810
	Calcium chloride $(CaCl_2)$	Control	98.087	99.750	99.750	—	—
		1	5.591	5.612	5.612	—	—
		3	0.741	0.741	—	—	—
		5	0.557	0.557	—	—	—
	Potassium nitrate (KNO_3)	Control	97.521	99.788	98.788	—	—
		2	98.209	98.570	96.826	—	—
		4	93.944	93.944	93.133	92.758	—
		6	91.257	93.373	91.810	88.871	83.681
	Ammonium carbonate $(NH_4)_2CO_3$	Control	98.468	99.722	99.722	—	—
		1	1.360	1.360	—	—	—
		3	1.803	1.803	—	—	—
		5	2.009	2.009	—	—	—
	Cane Wax	Control	99.144	99.772	99.772	99.578	—
		0.025[1]	98.937	99.615	99.772	99.471	—
		0.050[1]	99.182	99.709	99.628	99.623	—
		0.20[1]	98.830	99 615	99.628	99.628	—

[1] Usual amount was varied because the wax was not very soluble.

TABLE 1 (continued)

SAMPLE	IMPURITY	CONCENTRATION	T_1 = 2.5 HR.	T_2 = 3.5 HR.	T_3 = 4.5 HR.	T_4 = 5.5 HR.	T_5 = 6.5 HR.
		gm./100 ml.	Per cent sucrose	Per cent sucrose	Per cent sucrose	Per cent sucrose	Per cent sucrose
Centrifugal sugar	Sodium chloride (NaCl)	Control	96.055	96.281	97.062	97.062	—
		1	90.489	94.622	95.382	95.335	—
		3	79.494	86.428	90.909	97.840	92.840
		5	49.218	61.234	78.610	83.161	83.161
	Ammonium phosphate $(NH_4)_3PO_4$	Control	97.321	97.444	97.720	97.444	—
		1	97.360	97.720	97.721	97.662	—
		3	97.164	97.445	97.647	97.647	—
		5	97.321	97.720	97.460	97.567	97.567
	Ferric sulfate $Fe_2(SO_4)_3$	Control	95.961	97.062	97.062	—	—
		0.5	35.804	37.836	38.246	38.246	—
		0.75	29.190	29.525	29.999	29.999	—
		1.25	28.091	28.686	28.686	—	—
	Magnesium sulfate $(MgSO_4)$	Control	95.362	96.118	96.118	—	—
		2	95.189	95.591	95.527	—	—
		4	94.962	95.667	95.740	95.740	—
		6	94.859	95.591	95.565	—	—
	Potassium chloride (KCl)	Control	96.315	96.944	96.944	96.629	—
		1	95.316	95.895	95.934	95.934	—
		3	89.380	91.056	91.197	91.101	—
		5	83.724	85.400	86.456	86.447	—
	Calcium chloride $(CaCl_2)$	Control	97.337	97.774	97.774	—	—
		1	6.127	7.904	7.973	—	—
		3	5.863	5.262	5.262	—	—
		5	2.949	2.945	2.945	—	—
	Potassium nitrate (KNO_3)	Control	97.798	97.613	97.696	—	—
		2	97.455	97.421	97.444	97.444	—
		4	95.066	94.752	44.409	94.407	—
		6	91.478	91.634	94.211	85.802	—
	Ammonium carbonate $(NH_4)_2CO_3$	Control	97.186	98.006	98.006	—	—
		1	2.255	2.357	—	—	—
		3	2.466	2.671	—	—	—
		5	2.251	2.254	—	—	—
	Cane Wax	Control	97.376	97.775	97.775	—	—
		0.025[1]	97.267	97.787	97.737	97.737	—
		0.050[1]	77.376	97.737	97.801	—	—
		0.200[1]	97.312	97.763	97.635	—	—
Molasses	Potassium chloride (KCl)	Control	27.423	28.350	28.300	28.123	—
		1	27.304	21.796	27.926	27.913	—
		3	26.893	76.942	27.066	27.066	26.939
		5	23.503	23.526	23.508	23.329	—
	Ammonium phosphate $(NH_4)_3PO_4$	Control	25.144	25.900	25.695	25.614	—
		1	25.965	25.841	25.009	25.238	25.433
		3	25.731	25.782	25.693	25.555	—
		5	25.731	25.654	25.596	25.369	—

A COMPARATIVE STUDY OF THE NUTRITIVE VALUE OF THE CARCASSES OF SHEEP AND GOATS [1]

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This investigation was undertaken with the following objectives: (*a*) to determine the comparative percentage composition of the blood, internal organs, and wholesale cuts of the carcasses of sheep and goats, and (*b*) to ascertain the amount of nutrients contained in them.

The work was conducted in the Departments of Animal Husbandry and Agricultural Chemistry from January 27, 1935, to September 25, 1936.

Smith (1916)[2], citing the work of Lawes and Gilbert, gives the comparative analysis of the lean and fat of sheep, as follows: moisture, 63.5 per cent in lean, 51.5 per cent in fat; nitrogenous substances, 15.0 per cent in lean, 12.5 per cent in fat; non-nitrogenous substances (fat), 18.0 per cent in lean, 33.0 per cent in fat; mineral matter, 3.5 per cent in lean, 3.0 per cent in fat.

Morrison (1937)[3] presents a table based on certain investigations on the composition of bodies of farm animals and gives the percentage of moisture as 50.9 in fat lamb and 46.2 in fat sheep; protein, 17.4 in fat lamb and 13.0 in fat sheep; fat, 24.9 in fat lamb and 37.9 in fat sheep; mineral matter, 4.2 in fat lamb and 3.0 in fat sheep.

Carcasses of sheep and goats

The carcasses from five wethers, Nos. 86, 88, 90, 91, and 92, and five wether goats, Nos. 398, 409, 410, 414, and 419, were used. The sheep were grade Indians and the goats, grade Anglo-Nubians. They were all 18 months of age at the time of slaughter. For three months before they were butchered, each animal received a fattening grain mixture consisting of 5 parts of shelled corn, 3 parts of copra meal, and 2 parts of rice bran in amounts that each would consume readily each feeding time in the evening. The amount of grain consumed amounted to approximately one and a half per cent of the live weight in the case of the sheep and about one per cent of the live weight in the case of the goats. They received their roughage feed in the pasture where they were turned out in the morning and afternoon daily.

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[1] Experiment Station contribution No. 1222. Read before the Fourth Philippine Science Convention on February 23, 1937.

[2] SMITH, F. 1916. A manual of veterinary physiology. xi + 808 p., 259 fig. 1 plate. Chicago: Alex, Eger.

[3] MORRISON, F. B. 1937. Feeds and feeding. vi + 503 p., 126 fig. Ithaca, New York: The Morrison Publishing Co.

Preparation of samples for chemical analysis

One half of the carcasses of each animal was used in preparing the samples for chemical analysis. The bones from the wholesale cuts were removed and the lean tissues, together with the ligaments, cartilage, and fat, were passed through the meat grinder. Then the ground material was thoroughly mixed and from it a portion was obtained for analysis. With the internal organs, the intestines and stomach compartments were first thoroughly cleaned before they were prepared for sampling. The heart, lungs, liver, kidneys, and spleen were also ground and mixed, and samples were obtained from them for analysis. Samples of blood were secured from the material collected when the animal was bled.

Method of analysis

The methods of analysis indicated in the Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists[4] were followed.

RESULTS AND DISCUSSION

Table 1 shows the average analysis of the edible portions of wholesale cuts and of the internal organs and blood carcasses of sheep and goats.

It is evident that the average percentage of moisture was higher in all goat samples with the exception of the spleen and intestines. The average percentage of moisture in the spleen of sheep and goats was about the same, whereas the intestines of sheep had much greater percentage of moisture than those of goats. In ash, the internal organs of sheep had a higher average percentage, whereas the wholesale cuts of goats were richer than those of sheep. In general, the sheep had the advantage over the goats in the percentage of nitrogen-free-extract and fat present in the blood, internal organs, and wholesale cuts analyzed. Likewise, the calorific value was greater in sheep than in goats in almost all the materials studied.

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[4] ANONYMOUS. 1930. Official and tentative methods of analysis of the Association of Official Agricultural Chemists. 525 p., 25 fig. Washington, D. C.: Association of Agricultural Chemists.

Table 2 shows the average amount of nutrients contained in the blood, internal organs, and wholesale cuts of sheep and goats.

Owing to the greater size of the sheep carcass, the total amount of nutrients and the calorific value were generally more in the blood and various cuts and internal organs of sheep than in those of goats.

SUMMARY AND CONCLUSIONS

1. A study of the comparative nutritive value of the blood, internal organs, and edible portion of the wholesale cuts of the carcasses of sheep and goats is presented in this paper.

2. Five wethers and five wether goats of 18 months of age were used in the experiment. The sheep were grade Indians whereas the goats were grade Anglo-Nubians. Each animal had been given a fattening feed for a period of three months before they were slaughtered.

3. The blood of sheep was found to have a much lower percentage of moisture than that of goats but was higher in ash, protein, and fat, and about equal in nitrogen-free-extract. The blood of goats had the lowest percentage of ash but the highest percentage of moisture as compared with the internal organs and wholesale cuts of the same animal. The calorific value per kilogram of the material was much greater in the blood of sheep than in that of goats.

The amount of the different nutrients and calories contained in the blood of sheep was much greater than that in the blood of goats, except in nitrogen-free-extract, which was about the same in both classes of animals.

4. The percentage composition of the brain of sheep and goats was about the same, except in nitrogen-free-extract, which was more than double in sheep. The brain gave the richest percentage of ash among the internal organs, meat cuts, and blood of goats studied.

No marked difference was shown in the actual amount of nutrients contained in the brain of sheep and goats, except in nitrogen-free-extract, which was about three times greater in sheep.

5. The percentage composition and amount of nutrients present in the tongue of sheep and goats were found to be about equal although the percentage of nitrogen-free-extract in sheep was over twice that in goats.

6. The percentage of moisture in the heart of sheep was lower than in that of goats, whereas the percentage of nitrogen-free-extract and fat in sheep was much higher. Of ash and protein, the percentage was about the same.

There was not much difference in the actual amount of ash present in the heart of both classes of animals, but in other constituents and number of calories the sheep had much more.

7. The lungs of sheep and goats had about the same percentage composition, except in nitrogen-free-extract, which was about one-half as much in sheep as in goats. The lungs of sheep showed the lowest percentage of nitrogen-free-extract among the meat cuts, internal organs, and blood of the same animal studied.

The amount of the various nutrients and calories present in the lungs of sheep was greater than that in those of goats, except in nitrogen-free-extract which was more in goats.

8. There was a much higher percentage of fat in the liver of sheep than in that of goats. In other constituents, the percentage composition was similar.

The quantity of nutrients present in the liver of sheep and goats was about the same, except in fat which was much more in sheep. The sheep had also more calories.

9. The kidneys also showed similar percentage composition in both sheep and goats, except in fat which was more in goats. The same was true of the amount of nutrients contained in them with the exception of protein which was more in sheep. The sheep had also more calories.

10. The spleen of sheep and goats showed almost uniformly the same percentage analysis as well as in the quantity of nutrients it contained.

11. The percentage of nitrogen-free-extract and fat was more in sheep than in goats. In other constituents, the percentage composition was about the same in the two classes of animals.

The amount of the different nutrients as well as the number of calories in the stomachs of sheep was much greater than in those of goats.

12. The intestines showed the highest percentage of moisture but the lowest percentage of protein among the meat cuts, internal organs, and blood of sheep analyzed. The percentage of moisture was higher in the intestines of sheep but lower in nitrogen-free-

extract and fat than in those of goats. The percentage of protein was about the same in the two classes of animals.

The amounts of ash and protein were greater in sheep than in goats, whereas with nitrogen-free-extract, fat, and calories, the reverse was true.

13. All edible portions of the meat cuts of sheep gave lower percentages of moisture, ash, and protein than the corresponding cuts in goats. On the other hand, the percentages of nitrogen-free-extract and fat were higher in sheep than in goats. The amount of calories per kilogram of the edible portion of the meat cuts was higher in sheep than in goats.

Owing to the greater weight of the edible portion of the different wholesale cuts of sheep carcasses, the amount of nutrients in all of them was much higher than in the corresponding cuts in goats. The number of calories was also much higher in sheep.

14. The total possible amount of the different nutrients and calories which may be derived from all edible portions of the carcasses of sheep and goats including the blood, internal organs, and edible portion of meat cuts follows:

	SHEEP	GOATS
	gm.	*gm.*
Ash	145.6	105.5
Protein	2,705.2	1,985.5
Nitrogen-free-extract	663.3	258.6
Fat	3,475.0	1,051.3
Calories	45,631.0	18,976.0

15. From the edible portions of all the meat cuts the total amount of nutrients which may be obtained are as follows:

	SHEEP	GOATS
	gm.	*gm.*
Ash	105.6	77.6
Protein	2,128.5	1,557.3
Nitrogen-free-extract	548.2	160.1
Fat	3,220.4	881.4
Calories	40,452.0	15,238.0

TABLE 1

The average percentage of nutrients contained in the edible portion of wholesale cuts and in the internal organs and blood of carcasses of sheep and goats

MATERIAL	MOISTURE		ASH		PROTEIN		NITROGEN-FREE-EXTRACT		FAT		CALORIES PER KGM.	
	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*		
Blood	77.54	86.51	0.85	0.47	14.71	9.73	2.03	2.30	4.87	0.98	1,139	585
Brain	77.43	77.66	1.33	1.47	10.71	12.07	4.11	2.00	6.41	6.80	1,202	1,209
Tongue	64.86	67.92	0.97	0.87	14.75	14.92	4.47	2.03	14.94	14.26	2,178	2,021
Heart	67.23	76.75	0.93	0.94	16.07	15.06	7.65	2.09	8.13	5.16	1,729	1,183
Lungs	77.51	78.74	1.10	1.09	17.27	15.53	0.93	1.85	3.19	2.79	1,043	972
Liver	68.61	70.59	1.58	1.46	19.65	19.47	4.43	5.06	5.73	3.41	1,520	1,323
Kidneys	76.85	78.02	1.33	1.30	13.03	15.04	2.85	3.37	1.94	2.28	995	970
Spleen	76.59	75.04	1.48	1.46	15.94	17.04	3.25	4.38	2.94	2.08	1,060	1,071
Stomachs	76.47	79.68	0.86	0.73	11.99	12.62	2.52	0.98	7.97	5.98	1,336	1,114
Intestines	81.12	74.12	0.68	0.74	10.25	10.63	1.89	4.51	6.06	10.24	1,061	1,563
Chuck, including neck	57.97	63.38	0.79	0.92	16.25	18.97	3.65	1.78	21.34	8.95	2,821	1,683
Breast, including shanks	54.34	66.86	0.75	0.91	15.71	17.24	4.65	1.92	24.75	13.08	3,137	2,001
Hotel rack	52.34	66.37	0.72	0.88	14.85	19.86	5.75	4.91	26.34	7.98	3,411	1,758
Loin	49.73	66.79	0.72	0.91	16.03	18.48	6.08	1.95	27.44	11.87	3,462	1,941
Flank	45.56	67.04	0.62	0.80	13.37	17.52	1.96	2.41	18.49	12.22	4,208	1,954
Legs	61.23	70.58	0.87	0.95	15.30	18.39	2.12	0.75	20.45	9.33	2,616	1,653

TABLE 2

The average amount of nutrients contained in the edible portion of wholesale cuts and in the internal organs and blood of carcasses of sheep and goats

MATERIAL	ASH		PROTEIN		NITROGEN-FREE-EXTRACT		FAT		CALORIES PER KGM.	
	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat
	gm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*		
Blood	8.8	4.7	153.2	98.0	21.1	23.5	50.6	9.8	1,185	589
Brain	1.8	1.4	13.9	11.3	5.2	1.8	8.8	6.4	160	114
Tongue	0.8	0.8	12.4	14.0	3.3	2.0	13.0	13.5	185	190
Heart	1.1	0.8	20.0	12.9	9.7	1.8	12.6	4.6	217	103
Lungs	2.8	1.9	43.1	27.0	2.3	3.5	7.9	5.1	260	172
Liver	7.5	6.6	91.2	86.5	21.6	25.6	26.5	15.4	707	603
Kidneys	1.0	0.8	12.7	9.1	2.0	2.2	1.5	1.5	74	60
Spleen	0.7	0.5	7.0	6.1	1.4	1.5	1.3	0.7	46	38
Stomachs	9.3	5.6	131.5	96.0	32.1	7.5	77.0	45.8	1,387	850
Intestines	6.2	4.8	91.7	67.3	16.4	29.1	55.4	67.1	958	1,019
Chuck, including neck	25.4	17.6	521.5	362.1	113.9	35.3	715.8	183.6	9,329	3,337
Breast, including shanks	15.4	13.7	332.1	256.5	104.0	28.0	505.9	198.7	6,493	3,015
Hotel rack	11.5	7.2	248.5	160.5	103.7	46.3	415.2	64.1	5,560	1,444
Loin	11.3	7.0	274.8	142.7	114.2	16.9	456.4	99.7	5,046	1,581
Flanks	4.3	2.4	93.2	53.3	12.9	8.0	253.9	38.7	2,796	611
Legs	37.7	29.7	658.4	582.2	99.5	25.6	873.2	296.6	11,228	5,250
Total	145.6	105.5	2,705.2	1,985.5	663.3	258.6	3,475.0	1,051.3	45,631	18,976

DOES SHELLING BY MACHINE AFFECT THE GERMINATION OF CORN?[1]

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The cost of shelling by hand is rather high. Our figures for this item are from ₱1.20 to ₱1.26 for every cavan of corn grains. On the other hand, shelling by machine costs only from ₱0.06 to ₱0.08 for the same amount of corn. If it could be shown that shelling corn by machine has no detrimental effects on the seed, then the price of seed could be lowered by using this method of shelling in the preparation of seed.

The study herein reported had for its objects the following: (*a*) to determine the comparative effects on germination of hand shelling and machine shelling; (*b*) to find out if the cost of shelling seed corn with the use of corn sheller would be cheaper than hand shelling.

The experiments were conducted in the laboratory and in the Experiment Station fields of the College of Agriculture, from March, 1937, to August, 1937.

Materials used

Two varieties of corn were used in this study, Calauan Yellow Flint and Lagkit. The seeds were obtained from the 1937 dry-season harvest of the Department of Agronomy.

Thirty-three seed boxes were used for laboratory germination, and a piece of land about 2,060 square meters in area and located in the Experiment Station was used for germination test under field condition.

Methods

Methods of shelling. There were two methods of shelling seed corn employed, namely, (1) hand shelling and (2) machine shelling. In the hand shelling method about 120 good ears of Calauan Yellow Flint and 120 good ears of Lagkit corn were selected from the 1937 dry-season harvest. One-half of this number was hand shelled. The remaining half was machine shelled. The physical conditions of the hand- and machine-shelled grains were practically the same.

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[1] Experiment Station contribution No. 1223. Read before the Los Baños Biological Club, October 28, 1937.

The shelled grains were kept in four separate cloth bags properly labeled as to variety and method of shelling used.

Germination in seed boxes. The thirty-three seed boxes used were filled with sandy loam soil, which was subsequently pulverized. After the soil was thoroughly pulverized, it was leveled and little furrows were made. In the furrows the seeds were planted singly and distanced two centimeters apart. The method used was to plant one furrow with Lagkit corn seed, hand shelled, and the next furrow with the same variety of corn, machine shelled. The same procedure was followed for Calauan Yellow Flint corn. Five sowings were made for each variety of corn, and each sowing was finished on the same day it was started. Water was applied whenever the soil became apparently dry. After one week, the seeds that germinated were counted. After counting the germinated seeds, the soil in the seed boxes was again prepared for another sowing by repulverizing it, removing roots and corn grains that were left, and then leveling and furrowing it.

Germination in the field. The field was prepared as if it were to be used for a full season corn planting. Twenty furrows were made with a distance of about one meter between the furrows. In the furrow, seeds were planted at a distance of about 70 centimeters between hills, three seeds to the hill. The first ten rows were planted to Calauan Yellow Flint corn with alternate furrows of hand- and machine-shelled grains. The next ten rows were planted in the same manner to Lagkit corn. In the second sowing the land was again thoroughly prepared and the lot occupied by Calauan Yellow Flint corn was planted to Lagkit and vice versa, exchanging the position of each variety of corn in every sowing until the fifth sowing was made. The number of grains planted was recorded. After about a week the plants which germinated were counted.

EXPERIMENTS AND RESULTS

The results of these experiments are found in tables 1 to 7.

Table 1 shows the results of germination tests with Calauan Yellow Flint and Lagkit corn under seed box condition while table 2 presents the results of the tests in the field. Table 3 gives the mean percentage of germination of Calauan Yellow Flint and Lagkit varieties under seed box and field conditions.

Tables 4 and 5 present data on hand shelling corn by students: table 4, data on hand shelling by members of our farm management class; and table 5, by regular student laborers.

Tables 6 and 7 give data on shelling corn by machine: table 6, data on use of machine operated by hand, and table 7, data on use of the same machine operated by an engine.

DISCUSSION OF RESULTS

Reference to tables 1 and 2 shows that germination under seed-box condition was comparatively higher than under field condition. This seems to be true in the case of both the hand- and machine-shelled grains. This might be accounted for by the fact that when seeds were grown under laboratory conditions, they received better care as to shade and moisture than in the field.

As shown in table 3, under seed box condition, the mean percentages of germination of Calauan Yellow Flint were 98.26 ± 0.28 for machine-shelled and 97.34 ± 0.80 for hand-shelled grains. Their difference of 0.92 ± 0.85 was insignificant. The same variety under open-field condition gave a mean of 64.61 ± 3.76 per cent germination for machine-shelled and 65.41 ± 4.08 per cent germination for hand-shelled grains. The difference of 0.80 ± 5.55 was likewise insignificant.

In seed box Lagkit corn gave a mean percentage of germination for machine-shelled of 96.55 ± 0.74 and for hand-shelled, 97.07 ± 0.73, with a difference of 0.52 ±1.04 which was also insignificant. In open-field condition Lagkit corn gave a mean percentage of germination for machine-shelled of 54.50 ± 2.04 and for hand-shelled of 47.51 ± 3.00 with a difference of 6.99 ± 3.76 which was also insignificant. It would seem, therefore, that either of these methods may be recommended for shelling seed corn. However, before one method is recommended, it is necessary to know which is the cheaper one.

Table 4 shows the results of hand shelling by thirty-eight students. The students were given twenty ears of corn each to shell. The weight of the twenty ears was obtained and the time consumed for shelling the given number of ears was recorded. The volume and weight of grains obtained from the twenty ears were also recorded. It can be seen that the average time spent by the students in shelling the corn was 26.24 minutes and the average volume of grains was 0.91 ganta. Based on these results, the cost of shelling one cavan of corn at the rate of 0.10 centavos a student-hour was ₱1.20.

Table 5 shows the results of hand shelling corn by five student laborers. The students were allowed to shell corn ranging from one hour to three hours and their average time and volume of grains shelled were taken. It can be seen that the average time was 137.8 minutes and the average volume of grains shelled was 4.53 gantas. At 10 centavos per hour, the cost of shelling per cavan by student laborers was found higher by ₱0.06 than the cost obtained by members of Agronomy 9 class, and this may be explained by the fact that the members of Agronomy 9 class shelled corn for a shorter time than the student laborers. It is an established fact that in any manual work a laborer works faster in the first few minutes or hours, and slower towards the end of the day.

Table 6 shows the results of shelling corn by machine operated by hand. Five trials each of sixty minutes duration were made and the average amount of corn shelled in each trial was 129 gantas. There were four student laborers needed to operate the machine and to shell the corn, and at the rate of ₱0.10 per student-hour, the labor cost for shelling 129 gantas of corn amounted to ₱0.40. The total labor cost employed for shelling 129 gantas of corn amounted to ₱0.42, or ₱0.08 per cavan, including interest and depreciation of corn sheller.

Table 7 shows the results of shelling corn by machine hitched to a "Novo" engine. With the five trials made of sixty minutes per trial, the average number of gantas shelled was 261.8 per trial.

The total labor expense for one day using the corn sheller hitched to an engine was ₱5.87, or an equivalent labor expense of ₱0.65 an hour. Since the average output was 261.8 gantas an hour, the cost of shelling one cavan of corn was ₱0.06.

The data obtained in germination of corn and cost of shelling by hand and by machine favor the use of the latter in shelling corn. In connection with corn shelling, mention may be made of the popular belief among the Filipino farmers that the kernels from butt and tip of corn ears are not good for seed purposes and should, therefore, be discarded. Hand shelling allows the shelling of grains in different parts of the ear, and hence the separation of the kernels from the middle of the ear for seed purposes. In machine shelling, the whole ear is fed to the machine and the grains shelled are consequently mixed. This apparent disadvantage in the use of a shelling machine may be ignored for it was experimentally proved in the United States by a number of workers and locally by Mariano (1920)[2] that kernels from different parts of the ear had the same yielding value.

SUMMARY AND CONCLUSIONS

1. In the present study Calauan Yellow Flint and Lagkit corn, hand shelled and machine shelled, were tried for germination under seed box and field conditions.

2. It was found that there was no significant difference in percentage of germination between hand-shelled and machine-shelled seeds.

3. It costs from ₱1.20 to ₱1.26 to hand shell one cavan of corn grains; ₱0.08 to shell one cavan using the corn sheller run by hand; and ₱0.06 using the same sheller but run with an engine.

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[2] MARIANO, S. J. 1920. The relation of external characters of corn to yield. The Philippine Agriculturist 8: 345–358.

TABLE 1

Germination test of Calauan Yellow Flint and Lagkit corn under seed box condition

CALAUAN YELLOW FLINT

SOWING	HAND SHELLED			MACHINE SHELLED		
	No. of grains		Per cent germination	No. of grains		Per cent germination
	planted	germinated		planted	germinated	
			per cent			*per cent*
I	1638	1528	93.28	1761	1716	97.44
II	2160	2139	99.03	1725	1708	99.01
III	1892	1819	96.14	1892	1864	98.52
IV	2128	2124	99.81	2128	2111	99.20
V	4650	4577	98.43	4435	4308	97.13
Mean percentage of germination	97.34 ± 0.80			98.26 ± 0.28		

LAGKIT

SOWING	HAND SHELLED			MACHINE SHELLED		
	No. of grains		Per cent germination	No. of grains		Per cent germination
	planted	germinated		planted	germinated	
			per cent			*per cent*
I	2120	2099	99.01	2120	2078	98.02
II	2207	2157	97.73	2207	2161	97.92
III	2065	2047	99.13	2065	2026	98.11
IV	2020	1943	96.19	2020	1945	96.29
V	2183	2036	93.27	2183	2017	92.40
Mean percentage of germination	97.07 ± 0.73			96.55 ± 0.74		

TABLE 2

Germination test of Calauan Yellow Flint and Lagkit corn seed under open field condition

CALAUAN YELLOW FLINT

SOWING	HAND SHELLED			MACHINE SHELLED		
	No. of grains		Per cent germination	No. of grains		Per cent germination
	planted	germinated		planted	germinated	
			per cent			*per cent*
I	882	443	50.23	882	442	50.11
II	2205	1908	86.53	2205	1837	83.31
III	1680	997	59.34	1680	1086	64.64
IV	1830	1253	68.46	1830	1239	67.70
V	1890	1181	62.49	1890	1083	57.30
Mean percentage of germination	65.41 ± 4.08			64.61 ± 3.76		

LAGKIT

SOWING	MACHINE SHELLED			HAND SHELLED		
	No. of grains		Per cent germination	No. of grains		Per cent germination
	planted	germinated		planted	germinated	
			per cent			*per cent*
I	882	338	38.32	882	575	65.19
II	2205	1350	61.21	2205	1215	55.10
III	1680	840	50.00	1680	804	47.85
IV	1830	830	50.82	1830	1002	54.75
V	1890	703	37.20	1890	938	49.63
Mean percentage of germination	47.51 ± 3.0			54.50 ± 2.04		

TABLE 3

Summary of germination of hand- and machine-shelled corn seed under seed box and open field conditions

CALAUAN YELLOW FLINT

CONDITION OF GERMINATION	MACHINE SHELLED	HAND SHELLED	DIFFERENCE
Seed box	98.26 ± 0.28	97.34 ± 0.80	0.92 ± 0.85
Open field	64.61 ± 3.76	65.41 ± 4.08	0.80 ± 5.55

LAGKIT

CONDITION OF GERMINATION	MACHINE SHELLED	HAND SHELLED	DIFFERENCE
Seed box	96.55 ± 0.74	97.07 ± 0.73	0.52 ± 1.04
Open field	54.50 ± 2.04	47.51 ± 3.00	6.99 ± 3.76

TABLE 4

Data on corn hand shelled by 38 members of Agronomy 9 (1935–36) class

STUDENT	NUMBER OF EARS SHELLED	TIME CONSUMED IN SHELLING	VOLUME OF SHELLED CORN
		minutes	*gantas*
1	20	18	1.00
2	20	20	1.00
3	20	20	0.83
4	20	25	0.75
5	20	53	1.00
6	20	18	0.78
7	20	30	0.75
8	20	19	0.96
9	20	10	0.78
10	20	35	0.88
11	20	40	0.83
12	20	40	0.95
13	20	30	1.08
14	20	16	0.80
15	20	20	1.00
16	20	27	1.00
17	20	20	0.83
18	20	50	0.92
19	20	34	0.89
20	20	25	1.00
21	20	18	0.88
22	20	17	0.87
23	20	25	0.83
24	20	25	0.87
25	20	35	0.83
26	20	16	0.90
27	20	20	0.88
28	20	31	0.87
29	20	19	0.92
30	20	33	0.80
31	20	30	0.92
32	20	31	1.00
33	20	25	0.83
34	20	26	0.93
35	20	28	1.03
36	20	18	1.00
37	20	15	1.00
38	20	35	1.00
Average	20	26.24	0.91

TABLE 5

Data on corn hand shelled by student laborers

NUMBER OF TRIALS	NUMBER OF EARS SHELLED	TIME CONSUMED IN SHELLING	VOLUME OF SHELLED CORN
		minutes	*gantas*
1	199	200	7.00
2	81	60	2.75
3	200	200	6.00
4	82	148	3.67
5	74	148	3.33
6	99	148	4.33
7	117	120	5.17
8	130	120	5.67
9	80	96	2.89
Average	118	137.8	4.53

TABLE 6

Data on corn shelled by machine operated by hand

NUMBER OF TRIALS	VOLUME OF SHELLED CORN	TIME SPENT IN SHELLING
	gantas	*minutes*
First	130	60
Second	129	60
Third	132	60
Fourth	128	60
Fifth	126	60
Average	129	60

TABLE 7

Data on corn shelled by machine hitched to a "Novo" engine

NUMBER OF TRIALS	VOLUME OF SHELLED CORN	TIME SPENT IN SHELLING
	gantas	*minutes*
First	240.0	60
Second	257.0	60
Third	277.0	60
Fourth	265.0	60
Fifth	270.0	60
Average	261.8	60

A STUDY OF "SINGLE VALUE" SOIL PROPERTIES: STICKY POINT, ROLLING OUT LIMIT, AND TOTAL PHOSPHORUS CONTENTS OF SOME MAQUILING AREA SOILS[1]

NICANOR M. ALVARO

There has been considerable work done on the physical properties of soils, especially by British workers, in an attempt to secure a so-called "single value soil constant". Many kinds of determinations have been studied, such as, the quantity of clay fraction, water content of air-dried soil, the moisture of the soil when in equilibrium with air at a specified degree of humidity, loss on ignition, and moisture equivalent. One of the most promising attempts to define a soil by a single constant has been through the determination of the so-called "sticky point".

A knowledge of such physical properties of the soil as "sticky point" may be of direct help to the farmer, as this constant seems to be a measure of the maximum amount of water for satisfactory cultivation. At the sticky point, or below, the soil is workable because it does not adhere to the cultivating tools.

Robinson (1932) defines the sticky point as the moisture content of the soil in which the soil gels are just completely saturated, and it should be a value of distinct merit in defining and describing soils.

Several intensive soil surveys of the College campus and its vicinity have been carried out. Soil samples have been collected and physical studies have been made. There has been work also on measuring the hydrogen-ion concentration and the relative quantities of nitrogen, phosphorus, nitrates, etc., in large numbers of samples collected from the College grounds and adjoining places.

The present study attempts to evaluate physically, according to the sticky point and rolling out limit, and chemically, according to their phosphorus content, some soil samples collected on the College Farm and adjoining places. A very intensive soil survey was also made on the region between the Bureau of Public Works' quarry and the Manila Railroad line, east of the Naval Radio Station. This is the lowland rice field of the Economic Garden of the Bureau of Plant Industry. The work was carried out from July, 1934, to June, 1935.

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[1] Experiment Station contribution No. 1224. Prepared in the Department of Soils under the direction of Dr. R. L. Pendleton.

Review of literature

Keen (1920) considers that the colloidal material which exists in the soil is derived from the humus and the clay fraction and in most cases exerts a controlling influence on the water relationships. He assumed that this colloidal material coats more or less completely the soil grains, especially those of smaller size. Keen further stated that the imbibition of water by the colloidal material means that a soil, draining under the influence of gravity, will hold up more water than it would otherwise do, and, in addition, the reduction in diameter of the capillary pores as a result of the swelling of the gel material will tend to reduce this amount still further, owing to the production of smaller interstices between the soil particles. It would, therefore, be expected that the permeability of the soil to water will decrease with the increase in colloidal and organic content.

Hardy (1923) took the soil "constant" determined by the onset of stickiness on moistening an air dry soil to represent the point at which the free liquid films responsible for the internal tenacity of the structure are only just beginning to form. He assumed that it is only when the colloidal material of the soil is fully saturated with water that external adhesion becomes manifest. Hence, the moisture content of a soil at the "sticky point" is taken as a measure of the total imbibitional capacity of the colloid content.

Keen (1924) believed that the "movement of water in soil, and the manner in which water is distributed over the particles and within the aspects of moisture distribution, are of fundamental importance in soil science". In fact, in a study of the physical characteristics of the soil water, the translocation and relationship of its different forms have always received prime consideration.

Later, Hardy (1925) demonstrated the degree of swelling of soils caused by imbibition to be one of the factors causing differences in magnitudes of the percolation constants of the various colloidal soils he examined.

Wright (1926) declared that water in fully saturated colloids appeared to exist in two phases, "gel" water, which is absorbed by the walls of the "reticulum", and "vesicular" water, which fills the internal pores or vesicles.

Collison, Collison, and Harlan (1927) determined what soil properties affect most the yield of apple trees. Thirty Greening trees and twenty-two Baldwin trees were selected in the same orchard for high and low yields. Subsoil samples from 8 to 24 inches were taken from around each of the 52 trees. The sticky point of these 52 soils correlated to a considerable extent with their total carbon and colloid content, but much more with the amount of exchangeable calcium which is present in their absorption complexes. The structure and properties of soil colloids have apparently been a much more important factor in affecting Baldwin apple tree yields than has the total amount of such colloids. Exchangeable calcium present in these soils has not only been an important factor of the soils, but the changes in physical properties which it caused have apparently also significantly affected Baldwin yields.

Keen and Coutts (1928), working on certain English and Indian soils, and Coutts (1929), experimenting with Natal soils, observed that the clay content, loss on ignition, "sticky point", and the water content in equilibrium with an atmosphere of 50 per cent relative humidity are closely correlated with one another and that the sticky point and loss on ignition give a better estimate of the colloidal status of the soil.

Keen and Coutts (1928) indicated that the percentage of water in a soil at sticky point is directly proportional to the colloidal content of the soil.

Coutts (1929) and Marchand (1931) have pointed out that sticky point water and water capacity as determined by the Keen Raczkowski box experiment are closely related.

Studies of heavy plain soil moisture problems carried out by Finnel (1929) have shown that the moisture content of the soil is one of the important factors that affect crop production.

Using the technique described by Keen and Coutts (1928), West (1931) found that the "sticky point" is a convenient "soil constant" for use in correcting variations in soil texture in field studies of soil moisture. He observed that there was a degree of correlation between the moisture content and "sticky point" of soils in moisture equilibrium.

Since the physical characteristics measured in the present work are more or less directly related to the amount of colloid content of the soil, it is, therefore, proper to mention some work that has been done on the colloidal content of soils. Espino[2] found that the colloid content of Philippine soils varied widely, ranging from a trace to as high as 67 per cent. The samples collected from Muñoz, Nueva Ecija, showed an almost uniform colloid content, ranging between 50 and 67 per cent. Komkris[3] made a detailed investigation of 70 Philippine soils and found that soils with higher percentages of the clay fraction gave higher ignition losses, moisture contents, and "sticky point" values. The "sticky point" seemed to depend upon both the organic and inorganic colloids (clay fraction) present, but a closer association was observed between sticky point and the organic colloidal content.

MATERIALS AND METHODS

Some of the soil samples used in the present work were collected by the writer from a portion of the Economic Garden, Los Baños, Laguna; the rest of the soil samples had already been collected and were in storage in the Department of Soils.

The physical analyses made concerned "sticky point" and rolling out limits; the chemical analysis was devoted solely to the determination of the amount of phosphorus.

Preparation of soil samples. The preparation of the different soil samples was carried out in the approved manner used in the Department of Soils. The collected soil samples were dried in a well-ventilated cool place. The lumps of the air-dried samples were reduced to small particles. The amount of sample taken depended upon the amount of soil needed for analysis. This was separated and was pulverized with the aid of a wooden hammer. Then the sample was passed through a sieve having circular holes 1 mm. in diameter. Effort was made to so grind the soil that all of it would pass through the sieve. The sieved sample was carefully labeled and preserved for analysis.

Description of the experimental method. For the sticky point and rolling out limit determinations, the method and technique prescribed by Keen (1931) was followed.

Volumetric determination of phosphorus was determined in accordance with the method of Willey (1931).

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[2] Espino, Herminio R. The colloid content of tropical soils. (Thesis presented for graduation with the degree of Bachelor of Agriculture. 1931. Unpublished.)

[3] Komkris, Thuan. A study of single value soil properties: moisture relationships, loss on ignition, and sticky point, and amount of clay. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture. 1933. Unpublished.)

OBSERVATIONS AND RESULTS

The soil samples used in the experiment included representatives of the following series: Nanhaya, Calumpang, Lipa, Los Baños, Ibaan, and Macolod.

The Calumpang series is a recent alluvial soil found mostly along streams and on low plains. The topography is flat. The soil is characteristically deep. The surface soil is light grayish brown to brown, friable, and about 20 cm. deep. The subsoil is brown to bluish gray, slightly heavier in texture, and extends to a minimum depth of 60 cm. The series represents the accumulation of sediment brought down by the streams. This series is represented by five soil types: namely, silt loam, very fine sandy loam, clay, sandy loam, and gravelly sandy loam.

Calumpang silt loam. The surface soil is grayish brown to brown silt loam, loose, friable, easy to cultivate, well drained, and fairly retentive of moisture. The horizon ranged from 5 to 10 cm. in depth. The surface soil had been deposited by the stream. The second layer or subsurface is light brown to dark brown, light clay loam to medium clay loam, moderately sticky, and extends downward from 5-10 to 25 cm. The subsoil is light grayish brown to bluish gray, sticky, moderately compact, and characteristically wet. It ranges from 15 to 90 cm.

Calumpang very fine sandy loam. The surface soil is light grayish brown to light brown, porous, friable, easy to cultivate, well drained, and poor in moisture retention. This horizon ranges from 10 to 20 cm. deep. The subsurface is grayish brown to brown clay loam with brown iron veins, friable, moderately sticky, slightly porous, easy to cultivate; the depth is about 10-20 to 30 cm. The subsoil is light brownish gray to bluish gray mottled clay loam, sticky, coarse, and moderately compact. The depth varies from 20-25 to 90 cm.

Calumpang clay. The surface soil is from dark brown to grayish black heavy clay, moderately compact, sticky, and hard to cultivate; it shrinks considerably, causing wide cracks when dry. The depth ranges from 5 to 25 cm. The subsoil is brownish gray to bluish gray mottled clay, sticky, moderately compact, varying in depth from 5-25 to 95 cm. In this soil body there is quite a large hot spring; and at a depth of from 40 to 70 cm., varying with the distance from the spring, the soil is hot. It was also observed that the temperature of the subsoil is higher than the surface soil.

Calumpang sandy loam. The surface soil is brownish gray to light brown sandy loam, porous, friable, loose, easy to cultivate. It has a depth of 10 to 20 cm. The subsurface soil is light brown mottled clay loam, friable, and porous; it has a depth of 10-20 to 30 cm. The subsoil is brownish gray clay loam, sticky, moderately compact, and has a depth of 10-30 to 70 cm.

Calumpang gravelly sandy loam. The surface soil is grayish brown to light brown mottled, gravelly sandy loam; it is porous, friable, and easy to cultivate. It has a depth ranging from 15 to 45 cm. The subsoil is light grayish brown to dark brown mottled clay loam, slightly friable, and sticky. The depth is from 15-45 to 95 cm.

Vegetation as found for each soil type

Calumpang silt loam. The soil type comes from almost one-third of the area and it is devoted to rice culture. It was observed that the growth of rice was not luxuriant. The leaves were greenish in color. The soil is fairly well adapted to rice.

Calumpang very fine sandy loam. It occupies about one-eight of the total area and is devoted to rice culture. Those plants on the elevated portion of the area were fairly vigorous but those growing on the lower portions were stunted and had yellowish leaves.

Calumpang clay. This soil type covers almost one-half of the area. It is uncultivated. Weeds were growing fairly well.

Calumpang sandy loam. This soil type occupies about one-fifteenth of the area. A portion of this type is planted to rice and corn.

Calumpang gravelly sandy loam. This soil type is uncultivated and occupies one-fortieth of the area.

The results of this study are presented in tables which are on file in the Department of Soils. These are summarized as follows:

Table 1 shows the summary of physical and chemical analyses made (sticky point, rolling out limit, phosphorus, and moisture content for each soil type).

Table 2 shows the summary of physical and chemical determinations obtained for each soil series.

DISCUSSION OF RESULTS

It may be seen from the data presented in table 1 that the different soil types showed variations in sticky point and rolling out limit. The results show that there is a marked difference between the surface and subsoil in the percentage of moisture at sticky point and rolling out limit. The subsoil was found to have a higher percentage of moisture than the surface soil. This finding is in conformity with the findings of West (1931) who showed a greater moisture content at sticky point at a depth of 35 cm. than at 30 cm. In the soil types such as Calumpang silt loam, very fine sandy loam and sandy loam, the surface soil has a higher percentage of moisture at sticky point and rolling out limit than the subsoil. This may be explained by the topography of the land and the action of intermittent streams and also floods. It was observed that within the preceding six months the soil types have been repeatedly inundated and eroded. During the floods, great quantities of sediment from the quarry were deposited over certain parts of the area. That is why the top soil has textures varying from sandy to silty loams, except on the northern portion. The southern part of the area from which these soils have been collected was partly washed out and covered over with stones and gravel. As a result, the surface soil from the upper portion of the area had been transported to the lower portions so that the subsoil of the upper portions of the area was exposed and a mixture of surface soil and subsoil was found in the lower portion of the area. Such an arrangement of the soil horizon is abnormal. Calumpang gravelly sandy loam gave zero sticky point and zero rolling out limit for the surface soils, probably because of the absence or only traces of colloids in the samples. The soil type which gave the highest value for sticky point was Calumpang clay (48.55 per cent for the surface soil); Calumpang loam (28.01 per cent) was the lowest. Macolod clay loam gave the highest value for rolling out limit (36.11 per cent for the surface).

Table 2 shows that in comparing the series as a whole, the Los Baños series exhibits the highest sticky point value (42.39 per cent for the surface soil and 46.85 per cent for subsoil). The lowest for sticky point was the Lipa series which was 32.28 per cent for surface soil and 45.50 per cent for subsoil. In rolling out limit, Ibaan series exhibited the highest amount of moisture, 32.75 per cent for surface soil, and Lipa series, the lowest, 21.38 per cent. The differences in the sticky point and rolling out limit values may be attributed to the differences in the amount of soil colloids, clay, and organic matter present in the soil.

The phosphorus content of the soil samples as shown in table 2 varied considerably. In general, the surface soil contained a higher percentage of phosphorus than the subsoil. Comparing the surface soil of the different soil series as a whole, the Macolod series had the highest percentage of phosphorus and the Calumpang series, the lowest. The low amount of phosphorus in this series might be due to the fact that the area from which the soil samples have been collected has been repeatedly flooded and eroded; hence, some of the phosphorus content has probably been leached out. During the six months preceding, the area covered by the Calumpang series was flooded by the stream coming from the quarry; therefore, much of the phosphorus content of the soil might have been carried away by the water. By analysis of the soil the potential nutrient supply is found but not the proportions in which the plants will take in such nutrients to make a proper growth. No correlation with the possible crop yield could, therefore, be drawn from the results of the study. The results of the phosphorus determination revealed that there is still a fair amount of phosphorus, yet all of it might not be readily available for immediate use of the plant.

SUMMARY AND CONCLUSIONS

The following "single value" constants have been determined for some Philippine soils: sticky point and rolling out limit. The phosphorus content of the soil was also determined. The main features of the study may be summarized as follows:

1. The single values as sticky point and rolling out limit varied considerably.
2. A soil type may be high in sticky point but low in rolling out limit, as was the case in the Calumpang series.
3. There is a marked difference between the surface soil and subsoil in their capacity to hold water.
4. Generally, the surface soil contained more phosphorus than the subsoil.
5. No correlation could be drawn between the soil fertility and values obtained as no history of the soil vegetation was available.

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TABLE 1

Summary of averages of the physical and chemical analyses obtained in each soil type

SOIL TYPES AND PHASES	HORIZON	STICKY POINT	ROLLING-OUT LIMIT	TOTAL P_2O_5	MOISTURE CONTENT
		per cent	*per cent*	*per cent*	*per cent*
Nanhaya clay	Surface	37.25	31.89	0.1190	11.60
	Subsoil	47.36	37.16	0.0922	16.59
Calumpang loam	Surface	28.01	14.39	0.0943	7.70
	Subsoil	37.86	31.12	0.0876	10.70
Calumpang clay loam, deep	Surface	34.36	20.50	0.1018	9.19
	Subsoil	37.96	23.61	0.0765	10.35
Lipa clay loam, shallow	Surface	29.25	22.56	0.2014	11.36
	Subsoil	40.79	30.01	0.1331	17.56
Lipa clay loam, medium	Surface	36.17	26.46	0.2037	11.92
	Subsoil	44.82	31.03	0.1745	15.52
Lipa clay loam, deep	Surface	38.13	23.51	0.2043	11.44
	Subsoil	48.26	32.98	0.1719	16.10
Lipa silty clay loam	Surface	32.91	18.90	0.1323	9.42
	Subsoil	52.92	33.74	0.0910	15.25
Lipa loam, deep	Surface	24.96	15.49	0.1148	7.69
	Subsoil	39.69	31.42	0.1085	14.58
Los Baños clay loam, shallow	Surface	43.27	22.82	0.1986	13.82
	Subsoil	40.71	26.43	0.1355	15.94
Los Baños clay loam, medium	Surface	39.60	29.59	0.1409	12.51
	Subsoil	49.36	33.70	0.1083	15.97
Los Baños clay loam, deep	Surface	44.18	29.16	0.1879	11.90
	Subsoil	47.00	31.09	0.0860	16.06
Los Baños clay loam, medium steep	Surface	42.52	22.85	0.1131	10.38
	Subsoil	50.33	32.04	0.0718	13.48
Ibaan clay loam, shallow	Surface	41.14	32.75	0.1818	11.66
Macolod clay loam	Surface	42.07	36.11	0.2623	10.65
Macolod clay loam, sloping	Surface	39.81	31.90	0.2543	9.15
Calumpang silt loam	Surface	42.23	31.22	0.1656	9.80
	Subsurface	39.75	27.70	0.1464	9.14
	Subsoil	33.58	26.30	0.0888	9.87
Calumpang very fine sandy loam	Surface	40.28	26.94	0.1249	7.67
	Subsurface	38.90	26.99	0.1134	7.92
	Subsoil	38.08	22.10	0.0722	8.61
Calumpang sandy loam	Surface	40.11	27.52	0.0639	8.25
	Subsurface	37.08	22.13	0.0511	7.77
	Subsoil	36.04	21.07	0.0623	8.33

TABLE 1 (continued)

SOIL TYPES AND PHASES	HORIZON	STICKY POINT	ROLLING-OUT LIMIT	TOTAL P_2O_5	MOISTURE CONTENT
		per cent	*per cent*	*per cent*	*per cent*
Calumpang gravelly sandy loam	Surface	—	—	0.0770	7.18
	Subsurface	38.09	26.18	0.0673	7.21
	Subsoil	36.76	27.66	0.0621	7.24
Calumpang clay	Surface	48.55	35.42	0.1245	12.34
	Subsurface	46.49	40.80	0.1230	12.73
	Subsoil	51.35	40.37	0.0763	13.82

TABLE 2

Summary of averages of the physical and chemical analyses obtained in each soil series

SOIL SERIES	HORIZON	STICKY POINT	ROLLING-OUT LIMIT	TOTAL P_2O_5	MOISTURE CONTENT
		per cent	*per cent*	*per cent*	*per cent*
Nanhaya	Surface	37.25	31.89	0.1190	11.60
	Subsoil	47.36	37.16	0.0922	16.59
Calumpang	Surface	39.44	27.25	0.1044	8.91
	Subsoil	38.80	27.46	0.0751	9.85
Lipa	Surface	32.28	21.38	0.1713	10.37
	Subsoil	45.30	31.84	0.1378	15.80
Los Baños	Surface	42.39	26.11	0.1601	12.15
	Subsoil	46.85	30.82	0.1004	15.36
Ibaan	Surface	40.24	32.75	0.2513	12.00
Macolod	Surface	40.94	34.01	0.2583	9.90

ABSTRACT

The cost of producing Calauan Yellow Flint corn from detasseled and non-detasseled plants. MACARIO P. CORALES. (*Experiment Station Contribution No. 1225.*)—One way of securing higher yield of corn is the use of seed produced under conditions in which inbreeding is minimized. Such seed is produced by detasseling every other row of corn so that the cross-pollination of the detasseled plants, which are used as sources of seed, is insured and self pollination, and hence inbreeding, prevented. It has been found that by detasseling every other row of corn plants grown from seed of detasseled individuals the yield is increased. It is not known, however, whether the increase in yield would pay or not for the extra labor spent in detasseling. With the objects of determining the cost of producing corn from detasseled and non-detasseled plants and whether it would be profitable or not to detassel corn, this work was undertaken by the author.

The Calauan Yellow Flint corn, which is a strain of the Native Yellow Flint variety and which is grown on a large scale in the College of Agriculture and in almost all municipalities of Laguna province, was used in this study. In this investigation two plantings were studied. Two hundred ears, mass selected in a field of corn grown by Agronomy 13 students, were used in the first planting. From the second planting the same number of ears, mass-selected from the non-detasseled plants of the first planting, were used as planting materials. The field for each planting had an area of 7,000 square meters. One hundred furrows 70 meters long and one meter apart were planted in each culture. The seeds were planted by hand. The distance of planting was 80 cm. between hills and one meter between rows; there were 75 hills to a row. Four to five seeds were planted to a hill, and later the plants in each hill were thinned to two. Detasseling was done on every other row as soon as the tassels emerged and before the flowers opened. The tassels were cut just above the youngest leaf that comes out with the tassel.

The following conclusions were drawn by the author from the results of his experiments:

1. The computed yield for both cultures was higher on the detasseled plants than on the non-detasseled ones, the differences being

2.54 ± 0.34 cavans of shelled corn in the wet season and 2.40 ± 0.45 cavans in the dry.

2. The computed cost of the produce per hectare were ₱82.34 in the wet and ₱83.42 in the dry season for the detasseled rows; and for the non-detasseled, ₱75.35 in the wet and ₱76.92 in the dry season.

3. The total labor expenses of producing corn per hectare were ₱51.74 in the wet and ₱63.20 in the dry season for the detasseled plants, and ₱50.03 in the wet and ₱61.49 in the dry season for the non-detasseled plants.

4. The cost of production was higher by ₱1.71 per hectare in the detasseled plants than in the non-detasseled ones in both the wet and dry season cultures.

5. The gain per hectare in the wet season was ₱30.60 and in the dry ₱20.22 for the detasseled plants, and ₱25.32 in the wet and ₱15.43 in the dry season for the non-detasseled plants.

6. That the value of the increase in yield of the detasseled plants was more than enough to cover the extra expense involved in removing the tassels was found true in this experiment. The differences between the gains per hectare from the detasseled plants and those from the non-detasseled ones were ₱5.28 in the wet and ₱4.79 in the dry season.

—Abstract by Vicente B. Aragon

COLLEGE AND ALUMNI NOTES

Forty-two candidates received their degrees from the College of Agriculture at the twenty-eighth annual commencement exercises of the University of the Philippines held in Manila on March 29: *Bachelor of Science in Agriculture*—Felipe T. Agdeppa, Adriano S. Braga, Jesus Ma. Crisologo, Andres M. de la Cruz, Norberto P. Diaz, Isidro C. Dumaua, Saluey Emasiri, Pablo C. Enrile, Andres B. Fernandez, Antonio C. Gianzon, Catalino P. Javier, Jacinto G. Lagtapon, Raymundo S. Laher, Teopisto L. Loredo, Magno M. Mamañgon, Guillermo R. Manalo, Concordio C. Mandac, Ramon G. Mercado, Antonio R. Ocampo, Vicente A. Orque, Roque C. Pacariem, Prudencio O. Pacumbaba, Ernesto B. Padilla, Francisco O. Palis, Cecilio A. Pangga, Praduang Pradipasen, Krui Punyasingh, Melanio G. Rana, Horacio C. Recidoro, Felix B. Remigio, Eufemio C. Salera, Benigno G. Talamisan, Bartolome B. Tan, Francisco B. Tetangco, Julian P. Tiangsing, Democrito Topacio, Remberto Z. Ver, and Lorenzo P. Zialcita (*magna cum laude*). *Bachelor of Science in Sugar Technology*—Trinidad Q. Alconcel, Lauro M. Catapang, Severino S. Diaz, and Juan C. Fandialan.

The Baker Memorial Scholarship award for 1938 was made to Mr. Andres M. de la Cruz. The scholarship, which consisted of the proceeds from the Baker Fund raised from voluntary contributions of the former students, friends, and admirers of the late Dean Baker, is usually granted once a year to a self-supporting senior on the basis of "character, promise of future usefulness, and scholarship."

The Joaquin J. Gonzalez medal, granted to the candidate for graduation with the highest scholarship record for the entire course, was awarded to Mr. Lorenzo P. Zialcita. Mr. Zialcita graduated *magna cum laude*, a distinction given for the first time by the College. The donor of the medal, Mr. Joaquin J. Gonzalez, '19, a brother of Dean Gonzalez, was present for the first time at the annual meeting, where he personally presented the medal.

Papers read at the one hundred and thirty-eighth scientific meeting of the Los Baños Biological Club held in the lecture hall of the Agricultural Botany Building on March 24:

Mr. Mamerto D. Sulit, Dr. Joaquin Marañon, and Miss Luz Ll. Cosme. Cultural and chemical studies of derris grown in the Bureau of Forestry Nursery, Los Baños, Laguna. (Read by Dr. Marañon.)

Dr. Antonio I. de Leon and Mr. Felipe T. Agdeppa. The hydrogenation of mixed oils. (Read by Dr. de Leon.)

Dean B. M. Gonzalez was elected chairman of the National Research Council of the Philippines at a meeting of the new executive board on March 22.

Three members of the faculty of the College read papers before the plenary sessions of the Fourth Alumni Institute of the University of the Philippines held in Manila: Dr. N. B. Mendiola, on Filipino ornamental gardens and ornamental plants, on March 21; Dr. L. B. Uichanco, on the probable cause and trends of outbreaks of the Oriental migratory locust, March 23; and Prof. J. E. Velmonte, on farm tenancy problems in the Philippines with particular reference to tenancies in rice-producing regions, March 24. Dean Gonzalez presided at the last plenary session, on March 29.

Dr. Valente Villegas, assistant head of the Department of Animal Husbandry, left for Indo-China and Siam on March 14 to make a study of the livestock industry in those countries.

The seventh commencement exercises of the U. P. Rural High School was held on March 26 with Hon. Jose G. Sanvictores, a member of the Government Survey Board, as commencement speaker. Luz Baltazar was the valedictorian of the graduating class, and Domingo Alcasid, the salutatorian.

The SAR (Society for the Advancement of Research) elected as its officers for 1938-39 on March 17 Dr. Valente Villegas, president; Prof. A. Racelis, vice-president. The Los Baños Biological Club's new incumbents for the same period are Dr. José B. Juliano, president, and Dr. José M. Capinpin, secretary.

A STUDY OF ORGANIC MATTER AND NITROGEN CONTENTS OF SOME PHILIPPINE SOILS[1]

José L. Golez

Oftentimes the cause of infertility of tropical soils is the lack of organic matter and nitrogen. For this reason, tropical soils are generally judged by the amounts of organic matter and nitrogen which they contain. A knowledge of the amounts of these two essential soil constituents in some Philippine soils should be of value in characterizing Philippine soils and in soil management practices in the Philippines; hence, this work was undertaken.

Throughout the literature of soil science one can easily obtain extensive and comprehensive study on the organic matter and nitrogen contents of soils. Among them, the recent papers of Villanueva and Lumang (1935), Hutchings and Martin (1934), Lyon and Buckman (1934), Anderson and Byers (1933), Salter (1931), Leighty and Shorey (1930), McLean (1930), Bear (1929), Jenny (1929), Robinson (1929), Robinson, McLean, and Williams (1929), and Waksman (1924) may be mentioned. With the exception of the work of Villanueva and Lumang, all of these works were carried out on foreign soils.

MATERIALS AND METHODS

Soil samples[a] collected from the different regions of the Philippines were used in this study, namely, from the Baguio region including Baguio, Trinidad, Muñoz, and Mirador; the Bicol region consisting the provinces of Albay, Camarines Norte, Camarines Sur, and Sorsogon; Tagaytay, Cavite; Maquiling area (College of Agriculture); Mindanao region from the provinces of Cotabato and Zamboanga; Dumaguete, Oriental Negros; Jolo, Sulu; and Aloguinsan, Cebu.

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[1] Experiment Station contribution No. 1228. Prepared in the Department of Soils under the direction of Drs. D. I. Aquino and N. L. Galvez.

[a] With the exception of the soil from Tagaytay, Cavite, all the samples used in this study were collected in the summer of 1930 by Dr. Robert L. Pendleton, former head of the Department of Soils, College of Agriculture. The Tagaytay soils were supplied by Dr. M. M. Alicante and Mr. D. Z. Rosell, of the Bureau of Science, Manila.

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The air-dry soil samples were reduced to very small particles and then passed through a 1-millimeter mesh sieve. The sulfur dioxide method of Robinson, McLean, and Williams (1929) for determining organic carbon was used in ascertaining the amount of organic matter, in that the figures for carbon were multiplied by the factor 1.724. The total nitrogen content of the samples was obtained by subjecting the residue in the organic carbon determination to the Kjeldahl treatment.

RESULTS AND DISCUSSION

It may be seen in table 1 that the amount of organic carbon in the soil samples from Baguio varies from 1.84 to 7.16 per cent. This non-uniformity of figures is also true in the case of its organic matter contents which were obtained by multiplying the per cent of organic carbon by the factor 1.724. Its total nitrogen contents like that of the organic matter vary, too. Consequently, the carbon nitrogen ratios show likewise greater deviation from each other. It is very evident that results obtained from the soil samples from Baguio are fully corroborated by the findings from those from the regions of Bicol, Cavite, Maquiling area, Mindanao, Oriental Negros, Jolo, and Cebu.

Since subsoil plays an important role in the maintainance of soil fertility, its contents of organic matter and nitrogen were also determined and given in table 2. The data in table 2, as in table 1, point out that soil samples from the same region do not necessarily contain the same amount of organic matter and total nitrogen.

In table 3 the averages of the data obtained from the soil samples of the different regions used in this study show that the organic matter-nitrogen ratio is quite variable and with the exception of those from Bicol, there is a regular lowering of the ratio from the surface to the subsoil, this being the case in samples obtained from the regions of Baguio, Cavite, Maquiling, Mindanao, Oriental Negros, Jolo, and Cebu. According to Anderson and Byers (1933), McLean (1930), Leighty and Shorey (1930), and other soil workers, the carbon-nitrogen ratio is higher in the surface soil than in the lower horizons.

It is also obvious in table 3 that Baguio soils contain the highest amount of organic matter. This confirms the findings of Jenny (1928) who reported that the decomposition of organic matter in soils of lower temperature is much slower than in warmer soils. It is further shown in this table that in general regions with a higher amount of precipitation contain more nitrogen than those having lesser rainfall. Lievers and Holtz, as cited by Jenny (1928), have observed similar phenomenon.

SUMMARY AND CONCLUSIONS

1. Organic matter and total nitrogen contents of representative soil samples from the regions of Baguio, Bicol, Cavite, Maquiling area, Mindanao, Oriental Negros, Jolo, and Cebu were determined.

2. Samples from the same region showed variation in their nitrogen and organic matter content. It was found that the amount of organic matter in the surface soils was greater than the organic matter contained in the subsoils.

3. Soils of regions having different climatic conditions have different organic matter and nitrogen contents.

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TABLE 1

Organic carbon, organic matter, total nitrogen, and carbon-nitrogen ratio of some Philippine soils based on the oven-dry samples

Surface

BAGUIO SOILS

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
1	5.97	10.29	0.24	25.1
2	6.58	11.34	0.31	21.4
4	4.80	7.28	0.25	19.2
5	5.48	9.44	0.25	22.1
6	6.48	11.13	0.38	17.2
7[a]	6.33	10.91	0.36	17.4
7[b]	1.87	3.23	0.12	15.3
8[c]	3.42	5.89	0.23	15.1
8[d]	1.90	3.27	0.12	16.4
12	5.17	8.90	0.33	15.6
13	4.00	6.90	0.26	15.1
14	2.41	4.16	0.19	12.6
17	4.61	7.95	0.24	19.6
18	1.84	3.17	0.16	11.5
19	3.88	6.69	0.18	21.8
20	2.75	4.73	0.23	11.8
22	3.57	6.15	0.25	14.1
27	5.02	8.65	0.26	19.0
28	3.14	5.42	0.18	17.8
29	3.56	6.13	0.17	21.4
30	7.16	12.35	0.34	20.9
32	3.63	6.26	0.21	17.3

[a] Baguio series

[b] From San Juan, Basit, Maragol, Muñoz

[c] Baguio series

[d] From San Juan, Basit, Muñoz

TABLE 1 (continued)

BICOL SOILS (ALBAY, CAMARINES NORTE, CAMARINES SUR, AND SORSOGON)

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
1	3.49	6.01	0.25	14.2
5	2.69	4.64	0.15	17.5
9	2.92	5.03	0.12	24.1
11	4.92	8.49	0.41	12.0
15	2.35	4.05	0.24	9.7
19	4.07	7.02	0.37	11.1
21	3.08	5.31	0.22	14.2
23	2.71	4.66	0.19	14.5
25	2.98	5.12	0.24	12.6
28	3.13	5.40	0.22	14.0
30	3.19	5.50	0.20	15.6
36	1.38	2.37	0.10	13.3
39	2.63	4.54	0.34	7.7
42	3.40	5.86	0.46	7.6
49	3.02	5.20	0.25	12.1
51	2.33	4.02	0.52	4.5
57	4.19	7.23	0.53	7.9
59	5.29	9.11	0.49	10.7
64	2.62	4.52	0.16	16.9
66	2.77	4.78	0.38	7.3
71	1.40	2.42	0.21	6.6
74	2.10	3.61	0.18	11.7
CAVITE SOILS (TAGAYTAY)				
820	2.65	4.56	0.17	16.0
821	2.51	4.32	0.13	19.3
822	1.63	2.82	0.15	10.8
823	3.43	5.91	0.17	20.1
824	2.87	4.95	0.12	23.1
825	1.81	3.13	0.08	22.1
826	3.40	5.86	0.16	20.9
827	1.91	3.30	0.08	24.2
831	1.99	3.43	0.17	11.5
832	2.05	3.54	0.15	14.0

TABLE 1 (continued)

MAQUILING AREA SOILS

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
2	1.60	2.76	0.19	8.6
21	0.84	1.45	0.11	7.7
29	4.54	7.82	0.22	20.5
MINDANAO SOILS				
1	2.62	4.52	0.19	14.0
3	3.41	5.88	0.19	17.8
6	3.22	5.56	0.15	20.9
8	2.13	3.67	0.10	20.4
16	4.54	7.83	0.17	27.5
30	4.50	7.75	0.18	25.2
32	1.73	2.98	0.14	12.1
34	4.54	7.83	0.25	18.4
36	2.34	4.03	0.18	13.2
39	5.91	10.19	0.22	27.2
58	2.48	4.28	0.15	16.4
60	3.36	5.79	0.41	8.2
ORIENTAL NEGROS SOILS (DUMAGUETE)				
47	1.94	3.35	0.08	25.5
JOLO SOILS				
41	2.56	4.41	0.13	20.3
43	4.07	7.02	0.15	26.6
CEBU SOILS (ALOGUINSAN)				
51	2.40	4.13	0.16	15.2
55	3.48	5.99	0.03	6.3

TABLE 2

Organic carbon, organic matter, total nitrogen, and carbon-nitrogen ratio of some Philippine soils based on the oven-dry samples

Subsoil

BAGUIO SOILS

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
1	1.74	3.00	0.16	10.8
2	0.94	1.62	0.14	6.6
4	1.52	2.62	0.13	12.0
5	0.62	1.07	0.11	5.6
6	1.87	3.22	0.15	12.8
7[a]	3.44	5.94	0.21	16.6
7[b]	2.49	4.28	0.21	11.7
8[c]	1.12	1.94	0.07	16.5
8[d]	1.37	2.36	0.17	8.3
12	1.89	3.26	0.14	13.4
13	1.13	1.95	0.10	11.2
14	1.37	2.37	0.09	15.7
17	2.51	4.32	0.19	13.3
18	0.65	1.12	0.09	7.5
19	1.48	2.54	0.13	11.5
20	1.56	2.69	0.14	11.0
22	0.68	1.17	0.06	12.3
27	1.08	1.85	0.12	9.3
28	0.38	0.65	0.09	4.0
29	1.44	2.47	0.13	10.8
30	3.33	5.74	0.16	21.4
32	2.59	4.46	0.15	17.6

[a] Baguio series
[b] From San Juan, Basit, Maragol, Muñoz
[c] Baguio series
[d] From San Juan, Basit, Muñoz

TABLE 2 (continued)

BICOL SOILS (ALBAY, CAMARINES NORTE, CAMARINES SUR, AND SORSOGON)

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
2	0.52	0.90	0.06	8.2
6	0.75	1.28	0.09	8.4
10	1.36	2.35	0.08	18.1
12	3.86	6.66	0.31	12.2
16	2.03	3.50	0.18	11.4
20	1.43	2.47	0.06	25.6
22	1.64	2.83	0.22	7.4
24	1.79	3.08	0.13	14.0
26	1.52	2.63	0.09	17.3
29	1.53	2.64	0.11	13.9
31	2.18	3.75	0.17	12.6
37	2.14	3.69	0.17	12.6
40	1.29	2.23	0.18	7.1
43	1.88	3.24	0.07	20.6
50	4.40	7.59	0.16	28.5
52	0.98	1.70	0.05	18.9
56	1.83	3.16	0.15	12.3
58	2.05	3.53	0.43	4.8
60	3.76	6.48	0.21	17.5
65	0.48	0.83	0.06	7.8
67	1.57	2.70	0.31	5.0
72	0.85	1.47	0.12	7.1
75	1.25	2.16	0.05	25.5

TABLE 2 (continued)

MAQUILING AREA SOILS

STOCK NO.	ORGANIC CARBON	ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	per cent	*per cent*	*per cent*	
2	0.84	1.45	0.11	7.7
21	1.20	2.10	0.10	11.5
29	1.28	2.21	0.13	10.0
MINDANAO SOILS				
2	0.90	1.55	0.07	12.3
4	0.88	1.52	0.10	8.1
7	1.60	2.75	0.09	18.3
9	1.28	2.21	0.06	20.3
17	1.01	1.73	0.10	10.2
31	1.40	2.40	0.10	14.2
33	1.14	1.96	0.06	18.6
35	0.95	1.73	0.15	6.2
37	1.31	2.26	0.08	15.5
40	1.75	3.02	0.11	15.9
59	1.01	1.74	0.12	8.6
61	1.66	2.86	0.13	12.6
ORIENTAL NEGROS SOILS (DUMAGUETE)				
48	1.18	2.03	0.09	12.6
JOLO SOILS				
42	3.65	6.30	0.18	20.5
44	2.83	4.87	0.11	25.2
CEBU SOILS (ALOGUINSAN)				
52	0.17	0.29	0.03	6.3
56	1.67	2.87	0.14	11.5

TABLE 3

Averages of organic matter, total nitrogen, and carbon-nitrogen ratio

REGION	CLIMATIC CONDITION		ORGANIC MATTER	TOTAL NITROGEN	CARBON-NITROGEN RATIO
	Mean temperature	Mean rainfall			
	°C.	*mm.*	*per cent*	*per cent*	
Baguio	17.9	4,777			
Surface			7.28	0.24	17.98
Subsoil			2.76	0.13	11.82
Bicol	26.5	3,468			
Surface			5.22	0.29	12.08
Subsoil			3.16	0.15	13.77
Cavite	27.3	2,384			
Surface			4.18	0.14	17.20
Subsoil					
Maquiling area	27.1	2,384			
Surface			4.01	0.17	12.30
Subsoil			1.92	0.11	9.70
Mindanao	26.2	2,425			
Surface			5.78	0.19	18.44
Subsoil			2.14	0.09	13.40
Oriental Negros	26.7	1,329			
Surface			3.35	0.08	25.55
Subsoil			2.03	0.09	12.60
Jolo	26.2	2,424			
Surface			5.71	0.14	23.40
Subsoil			5.53	0.14	22.80
Cebu	26.9	1,707			
Surface			5.06	0.09	10.70
Subsoil			1.58	0.08	8.90

A PRELIMINARY STUDY ON THE PREPARATION OF SPROUTS OF DIFFERENT KINDS OF FIELD BEANS AND THEIR POSSIBLE USE FOR CULINARY PURPOSES [1]

Aurelia M. Capinpin

In the Philippines there are many kinds of field beans, but mungo (*Phaseolus aureus* Roxb.) is the only one used on a large scale in making sprouts. The present study was undertaken mainly to find out the possibility of preparing sprouts from other kinds of field beans.

Review of literature

Wiltshire (1919), Fenner (1923), and Chick and Delf (1919) reported that germinated seeds of beans possess antiscorbutic properties and that the amount of antiscorbutic vitamin developed in the beans upon germination was equal to, if not greater than, that contained in fresh lemon juice.

According to Santos (1921), *togue* (mungo seed sprouts) is fairly rich in vitamins B and C; and the vitamin B content was apparently increased on germination of the beans.

In Hawaii, Muller and Hair (1923) tested mungo bean sprouts for their vitamin A, B, and C contents in the raw and when cooked. They found that the sprout, both raw and cooked, was a fair source of vitamin A, a very good source of vitamin B, both raw and cooked, and an excellent source of vitamin C in the raw state and a good source in the cooked state.

Simonik (1929) traced the course of development of vitamin C in beans, vetch, and peas during germination. He concluded that conditions were rather more favorable for the formation of vitamin C during germination of legumes than of cereals.

Horvath (1930) found in his study on the blood of hens that feeding sprouted soybeans caused a rise in the globulin-albumin ratio of the blood serum of the hens.

Orosa (1932) and Hansen (1933) found that soybean sprouts may be prepared first by soaking the seeds in water for several hours and then putting them in a container with perforations in the bottom for drainage of excess water. The beans were then covered to keep out the light. The sprouts were ready for consumption in three to six days.

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[1] Experiment Station contribution No. 1229. Prepared in the Department of Agronomy under the direction of Assistant Professor Vicente B. Aragon.

Objects of the present work

The objects of the present work were: (*a*) to compare two methods of preparing bean sprouts, (*b*) to find if it is possible to prepare sprouts from varieties of field legumes other than mungo, and (*c*) to find if the sprouts of different varieties of field legumes are palatable and at what stage or stages the sprouts are fit for cooking.

Time and place of the work

The work was performed in the seed laboratory of the annual farm crops division, Department of Agronomy, from April 28, 1933, to January 30, 1935.

MATERIALS AND METHODS

Field beans used

In this study the following field beans were used: green and yellow varieties of mungo (*Phaseolus aureus* Roxb.), five varieties of cowpeas, namely, New Era, Black, Red, Kibal, and Gray, two varieties of patani (*Phaseolus lunatus* L.), the small white-seeded variety and the big purple-seeded variety, white variety of tapilan (*Phaseolus calcaratus* L.), green and yellow strains of Ami soybean variety, brown cadios (*Cajanus cajan* Sprengl.) and the winged bean (*Psophocarpus tetragonolobus* [L.] DC).

Preparation of pots used for sprouting seeds

The pots were thoroughly washed with tap water and then sterilized with boiled water. There were small holes in the bottom of the pots for drainage. Layers of rice straw were placed at the bottom of the pot to prevent the beans from falling through the holes.

Preparation of beans

The beans were put in tap water for a few minutes so the poor seeds, or those that would not germinate, would float. These were thrown away and those that sank in the water were collected and dried for use in this study. Two methods of preparing the sprouts were tried. The first method was to soak the beans in water overnight then put them in pots with a rice straw layer in the bottom. In the second method the beans were washed well, soaked in warm water at a temperature ranging from 70° to 80°C. for one, two, three, four, and five minutes so as to soften the seed coat and kill the mold or insects on the beans. The beans were then put in separate pots with rice straw in the bottom; these were covered and placed in a dark corner of the laboratory. In this phase of the experiment, five sets of three replications for each kind of beans in each set were prepared. In each replication, one deciliter of beans was used.

Care of the beans during the process of sprouting

During the first three days, the seeds in the pots were moistened twice a day, once in the morning and once in the afternoon. Beginning from the fourth day, they were watered only once a day, usually in the morning. During the process of sprouting, the pots were always kept covered in order to prevent light from getting to the sprouts. If light gets to the sprouts, these will become green and tough instead of blanched and tender.

Stages at which the sprouts were prepared for culinary studies

The sprouts were prepared for culinary studies in the following stages: (*a*) emergence of roots or radicle, (*b*) emergence of radicle and plumule, (*c*) emergence of folded leaves, and (*d*) when leaves had just opened.

For culinary studies the sprouts were tested in *guinisa, okoy,* and *salad.*

The sprouts at each stage were tried by the writer, five members of the faculty, and five students who were furnished with the samples and asked for comments on the palatability at the different stages for culinary purposes.

Guinisa. The sprouts were cooked either cut into small pieces or whole. The other ingredients—garlic, onion, pork, and shrimps—were fried in lard until brown. Then boiled sprouts, shrimp sauce (*patis*), or soy sauce, and pepper were added. The whole was covered and allowed to boil until cooked.

Okoy. Some flour was moistened with a little water, a well-beaten egg was added, and the whole stirred well. To this batter were added shredded green papaya and boiled bean sprouts, and the whole cooked by dropping it in cakes in deep hot lard. When the cakes were half-cooked, shrimp was put on each piece and frying was continued until brown. The *okoy* is eaten with a dressing of vinegar, finely mashed garlic, and pepper.

Salad. The sprouts were boiled until soft and a dressing made of vinegar, salt, and pepper was added. On the top of the salad were placed sliced hard-boiled eggs.

Determination of the increase in bulk of the sprouts

The increase in volume of the sprouts at different stages were determined. In this determination a deciliter measure was used. Before starting the experiment, the sets with their respective initial volumes were prepared. When each stage was ready for cooking tests, the increase was obtained by subtracting the initial volume from the final volume at the stage, the culinary properties of which were to be determined.

RESULTS AND DISCUSSION

The results of the experiments are presented in tables 1 to 5.

Methods of sprouting

Of the two methods of sprouting used, the one which consisted of soaking the seeds over-night in tap water before putting them in the pots was found to be more efficient than the one in which the seeds were immersed for from one to five minutes in hot water at a temperature ranging from 70° to 80°C. It may be seen in table 1 that the first method gave a higher percentage of germination than the second. For example, the average percentage of germination of cadios when soaked overnight was 90, whereas when the seeds were immersed in hot water for different lengths of time, as 1 to 5 minutes, cadios seeds ranged from 20.12 to 60.23.

In general, the sprouts were subject to fungus attack. In the case where the seeds were soaked over-night, the percentage of attack was much lower than when the seeds were immersed in hot water. It may be seen in table 1, also, that the longer the seeds were immersed in hot water, the lower was the percentage of attack of fungus, but the percentage was much higher than in seeds soaked over-night.

In the first method, the highest percentage of fungus attack, 6.35, was found in winged bean, and the lowest, 1.35, was found in big purple-seeded patani.

The highest percentage of fungus attack, 75.03, in the second method of sprouting was found in gray cowpeas which were immersed in hot water for 1 minute, and the lowest, 26.90, was found in green mungo immersed in hot water for 5 minutes.

When the different results obtained with the two methods of sprouting were compared, it was found that the method of soaking the seeds over night in tap water was more practical and efficient than the immersion of the seeds for from one to five minutes in hot water because sprouting in the former method not only occurred within a shorter time but it also gave higher percentage of germination and lower percentage of fungus attack than the latter method. The former method, therefore, was the one employed in the succeeding sets.

Stages of germinating beans

It may be seen in table 2 that the number of days required for germination of each variety was almost uniform. Mungo required an average of one day to germinate; the other beans, two days.

In the beans studied the emergence of the plumule did not take place in all at the same time. This was true even in the same variety of beans. Usually, however, the plumule emerged four days after the emergence of the radicle in cadios, cowpea, patani, soybean, tapilan, and winged bean, and three days in mungo. Nor did the emergence of leaves in all the seeds studied take place on the same day. This was true even in the same variety of beans studied. In the mungo, cadios, cowpea, patani, and soybean, the leaves emerged one day after the emergence of the plumule. In tapilan and winged beans, the leaves emerged after two days. The sprouts were said to be complete in germination, from the standpoint of their culinary properties, when the leaves were fully open. On an average, mungo required six days from emergence of the radicle to the time when the leaves were fully open. The cadios, gray and red cowpea, and green and yellow soybeans required eight days from emergence of radicle to the time when the leaves were fully open; and the black, kibal, New Era cowpea, two varieties of patani, tapilan, and winged beans required nine days.

In all the beans studied, the seed coat was still attached to the cotyledon at the emergence of the radicle and plumule. But upon the emergence of leaves, the seed coat was off. However, when sprouts are to be prepared for cooking, the seed coat can be removed easily by soaking the sprouts for a few minutes in hot water. In these experiments it was observed that the seed coats of mungo and soybeans were more easily removed than those of the other beans under study. It is interesting to note the relation of weather conditions to bean sprouting. In the course of the experiments it was observed that the beans on bright sunny days were not attacked by fungus, but the seeds and sprouts set on the rainy and cloudy days were badly attacked by a fungus, *Aspergillus* sp. The attack of fungus, however, upon the sprouts of mungo, tapilan, and winged bean was not as serious as upon cowpea, patani, cadios, and soybeans. The attacked beans were thrown away.

Length of sprouts at different stages

It may be seen in table 3 that the average length of the sprouts of each variety varied at different stages. This was to be expected for they belonged to different species. The average length of radicle at emergence in cowpea, two varieties of mungo, two varieties of soybean, tapilan, and winged bean was fifteen millimeters. At the emergence of plumule the average length of the sprouts of cadios, two varieties of patani, and winged bean was eighty millimeters; the five varieties of cowpea, eighty millimeters; two varieties of mungo and two varieties of soybean, ninety millimeters; and the tapilan, ninety-five millimeters. At the emergence of leaves of cadios, the sprouts were eighty-five millimeters long; two varieties of patani and winged bean, ninety millimeters; two varieties of mungo and two varieties of soybean, ninety-five millimeters; and the tapilan, one hundred and five millimeters. When the leaves were fully expanded, the average length of the sprouts of cadios was ninety millimeters; of kibal and red cowpea and two varieties of patani, one hundred millimeters; of black, gray, and New Era cowpea and two varieties of mungo, one hundred and five millimeters; and of tapilan and winged bean, one hundred and fifteen millimeters.

In general, the rate of growth in length of the sprouts can be classified into quick and slow. Those that fall under quick germinating sprouts in terms of length were the black, gray, and New Era cowpea, two varieties of mungo, two varieties of soybean, tapilan, and winged bean; and those under the slow germinating sprouts were cadios, kibal, and red cowpeas, and two varieties of patani. It is of importance to know this classification because for every increase in length there is a corresponding increase in bulk, or volume. Reference to table 2 will show that the quick germinating sprouts increased more in bulk than the slow germinating ones.

Palatability of the sprouts at different stages

Comments from the faculty members and students who tried the sprouts of different field legumes under study were unanimous in the opinion that the soybean sprouts were superior to all the others in palatability.

It may be seen in table 4 that the sprouts at the different stages studied were suitable for food, although the fibrous nature of the sprouts affected their quality. At the emergence of the radicle, all the sprouts of different varieties of beans were found to be eatable. At the emergence of leaves, the sprouts of the different beans were still edible but were fibrous. This is because as the plant grows, it becomes more fibrous. The four stages of growth, therefore, can be divided into two groups, the first group which is palatable, in which case the radicle and plumule are just out of the seed, and the second group which is less palatable, in which the folded leaves or fully opened leaves are just out. The latter is less palatable because of the fibrous nature of the sprouts. They may be rendered more palatable, however, by cutting the sprouts into pieces about one inch in length before cooking.

Chemical analysis

It may be seen in table 5 that as the sprouted beans advanced in age, the amounts of fats, protein, carbohydrates, and calorific value per 100 grams decreased. The amount of moisture, ash, and crude fiber, however, increased. It will also be noted that the different kinds of field beans can be prepared as sprouts and still be a good source of protein.

SUMMARY AND CONCLUSIONS

The present studies were concerned with the preparation of sprouts of different field beans and their possible use for culinary purposes. The results may be summarized as follows:

1. Two methods of preparing sprouts were tried: (*a*) soaking the seeds in water over night and placing them in a container with perforations in the bottom; the container with the beans was then placed in the dark; and (*b*) immersing the seeds in warm water for from one to five minutes and treating them as above. The first method was found the more efficient.

2. Mungo, the sprouts of which are known as *togue*, is the common bean used for culinary purposes. The present studies show that the sprouts of beans other than mungo, as cowpea, soybean, cadios, patani, tapilan, and winged bean, are suitable for the table.

3. The sprouts of different varieties of field beans were best for culinary purposes at the age of from two to six days. This is the stage when the radicle and the plumule emerge. Germinating

beans with fully expanded leaves are also suitable for table vegetable, although they are fibrous.

4. The chemical constituents varied according to the age of the sprouts. As the sprouts advanced in age, the amount of fats, protein, carbohydrates, and calorific value decreased; and the moisture, ash, and crude fiber contents increased.

5. The bean sprouts may be prepared for table use even at the stage with expanded leaves. This stage may be considered similar to young shoots of squash, sweet potato, and other plants prepared as vegetables.

6. The seven species of legumes represented by fourteen varieties proved to be suitable for culinary purposes, with some degree of palatability.

7. It is evident from these studies that when certain beans are not available, other kinds may be sprouted for culinary purposes.

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TABLE 1

Average efficiency of the two methods of sprouting field beans in five sets of three replications each

KINDS OF BEAN	VARIETY	SOAKED OVER-NIGHT			IMMERSED IN HOT WATER (70° TO 80°C)				
		Number of days required to sprout	Percentage of		Number of days required to sprout in				
			germination	fungus-attacked	1 min.	2 min.	3 min.	4 min.	5 min.
Cadios, *Cajanus cajan* (L.) Millsp.	Red	2	90.00	4.50	7	6	5	5	4
Cowpea, *Vigna sinensis* Endl.	Black	2	92.00	3.01	6	5	4	4	3
	Gray	2	90.54	2.05	6	5	5	4	4
	Kibal	2	93.30	3.12	6	5	4	4	3
	New Era	2	95.26	2.21	6	5	5	4	4
	Red	2	95.00	2.13	6	5	4	4	3
Mungo, *Phaseolus aureus* Roxb.	Green	1	95.32	1.52	5	4	4	3	3
	Yellow	1	97.17	2.80	5	4	4	3	3
Patani, *Phaseolus lunatus* L.	Small, white-seeded	2	93.32	1.61	7	6	5	5	4
	Big, purple-seeded	2	90.50	1.35	7	6	5	5	4
Soybean, *Glycine max* (Linn.) Merr.	Green	2	92.30	1.92	5	4	4	3	3
	Yellow	2	95.00	1.73	5	4	4	3	3
Tapilan, *Phaseolus calcaratus* Roxb.	White	2	90.50	2.01	5	4	4	3	3
Winged bean, *Psophocarpus tetragonolobus* (L.) D. C.		2	93.00	6.35	7	6	5	4	4

TABLE 1 (continued)

KINDS OF BEAN	VARIETY	IMMERSED IN HOT WATER (70° TO 80°C)									
		Percentage of									
		germination in					fungus-attacked in				
		1 min.	2 min.	3 min.	4 min.	5 min.	1 min.	2 min.	3 min.	3 min.	5 min.
Cadios, *Cajanus cajan*	Red	20.12	30.18	55.84	57.18	60.23	66.75	46.15	34.72	35.02	34.50
Cowpea, *Vigna sinensis*	Black	19.36	35.60	51.83	57.01	65.12	71.91	46.76	38.02	35.98	35.20
	Gray	19.78	39.11	52.78	57.75	62.30	75.03	45.78	34.82	34.05	33.20
	Kibal	22.01	35.78	51.65	50.72	60.25	69.95	49.07	38.82	38.35	38.20
	New Era	21.13	46.92	51.18	52.01	65.00	62.02	41.97	39.09	37.97	30.60
	Red	20.72	43.18	50.60	53.78	67.10	63.93	43.85	38.75	32.05	31.30
Mungo, *Phaseolus aureus*	Green	35.72	46.82	58.23	58.78	70.17	50.81	40.75	32.92	29.05	26.90
	Yellow	35.92	46.86	59.18	59.05	70.60	51.15	41.02	31.17	31.01	27.20
Patani, *Phaseolus lunatus*	Small, white-seeded	20.09	30.87	55.15	56.78	65.30	63.85	53.63	37.45	33.75	31.80
	Big, purple-seeded	20.79	31.17	57.16	58.21	60.51	64.95	53.87	33.18	33.07	32.70
Soybean, *Glycine max*	Green	22.11	46.82	55.87	55.17	69.00	55.75	39.54	35.07	35.15	29.90
	Yellow	25.10	46.76	58.98	56.85	65.50	54.75	39.68	33.48	33.13	32.17
Tapilan, *Phaseolus calcaratus*	White	19.98	32.11	50.16	54.03	55.60	57.01	49.83	35.79	35.11	35.80
Winged bean, *Psophocarpus tetragonolobus*		20.17	33.93	49.16	50.02	65.70	55.36	45.03	44.92	33.80	30.60

TABLE 2

Average number of days required for germination of each variety for the five sets

KIND OF BEANS	VARIETY	EMERGENCE OF RADICLE	EMERGENCE OF RADICLE AND PLUMULE	EMERGENCE OF LEAVES FOLDED	LEAVES FULLY OPEN	REMARKS
		days	*days*	*days*	*days*	
Cadios, *Cajanus cajan*	Red	2	6	7	8	Seed coat removed with difficulty
Cowpea, *Vigna sinensis*	Black	2	6	7	9	Seed coat removed with difficulty
	Gray	2	6	7	8	” ” ” ” ”
	Kibal	2	6	7	9	” ” ” ” ”
	New Era	2	6	7	9	” ” ” ” ”
	Red	2	6	7	8	” ” ” ” ”
Mungo, *Phaseolus radiatus*	Green	1	4	5	6	Seed coat removed with difficulty
	Yellow	1	4	5	6	” ” ” ” ”
Patani, *Phaseolus lunatus*	Small, white-seeded	2	6	7	9	Seed coat removed with difficulty
	Big, purple-seeded	2	6	7	9	” ” ” ” ”
Soy bean, *Glycine max*	Green	2	6	7	8	Seed coat removed with difficulty
	Yellow	2	6	7	8	” ” ” ” ”
Tapilan, *Phaseolus calcaratus*	White	2	6	8	9	Seed coat removed with difficulty
Winged bean, *Psophocarpus tetragonolobus*		2	6	8	9	Seed coat removed with difficulty

TABLE 3

Average length of sprouts at the different stages of each variety for the five sets

KIND OF BEANS	VARIETY	LENGTH OF RADICLE AT EMERGENCE	LENGTH OF RADICLE AND PLUMULE AT EMERGENCE	LENGTH OF LEAVES, FOLDED	LENGTH OF LEAVES, FULLY OPEN	INCREASE IN BULK			
						At emergence of radicle	Emergence of radicle and plumule	With leaves still folded	Leaves fully open
		mm.	*mm.*	*mm.*	*mm.*	*times*	*times*	*times*	*times*
Cadios, *Cajanus cajan*	Red	10	80	85	90	2	3	4	5
Cowpea, *Vigna sinensis*	Black	16	85	95	105	2	4	5	5.5
	Gray	15	85	95	105	2	4	5	5.5
	Kibal	15	85	95	100	2	4	5	5.5
	New Era	16	85	95	105	2	4	5	5.5
	Red	16	85	95	100	2	4	5	5.5
Mungo, *Phaseolus aureus*	Green	15	90	95	105	2	4.5	5	5.5
	Yellow	15	90	95	105	2	4.5	5	5.5
Patani, *Phaseolus lunatus*	Small, white-seeded	15	80	90	100	2	4	5	6
	Big, purple-seeded	15	80	90	100	2	4	5	6
Soy bean, *Glycine max*	Green	16	90	95	110	2	4.5	6	6
	Yellow	16	90	95	110	2	4.5	5	6
Tapilan, *Phaseolus calcaratus*	White	15	95	105	115	2	4.5	5	6
Winged bean, *Psophocarpus tetragonolobus*		15	80	90	115	2	4	5	6

TABLE 4

Palatability of the sprout of each variety of beans at the different stages

KIND OF BEANS	VARIETY	AT EMERGENCE OF RADICLE	AT EMERGENCE OF RADICLE AND PLUMULE	AT EMERGENCE OF LEAVES FOLDED	LEAVES FULLY OPEN	HOW USED
Cadios, *Cajanus cajan*	Red	Good	Good	Fair, but fibrous	Fibrous	In ginisa [a]
Cowpea, *Vigna sinensis*	Black	Good	Good	Fair, but fibrous	Fibrous	In ginisa
	Gray	”	”	” ” ”	”	” ”
	Kibal	”	”	” ” ”	”	” ”
	New Era	”	”	” ” ”	”	” ”
	Red	”	”	” ” ”	”	” ”
Mungo, *Phaseolus aureus*	Green	Good	Fair	Fair	Fibrous	In ginisa or in okoy
	Yellow	”	”	”	”	” ” ” ” ”
Patani, *Phaseolus lunatus*	Small, white-seeded	Good	Fair	Fibrous	Fibrous	In ginisa
	Big, purple-seeded	”	”	”	”	” ”
Soybean, *Glycine max*	Green	Good	Good	Good, but fibrous	Fibrous	In ginisa or salad
	Yellow	”	”	” ” ”	”	” ” ” ”
Tapilan, *Phaseolus calcaratus*	White	Good	Fair	Fibrous	Fibrous	In ginisa
Winged bean, *Psophocarpus tetragonolobus*		Good	Fair	Fibrous	Fibrous	In ginisa

[a] Tagalog name of dish, or recipe. *Ginisa*: sprouts with meat and shrimps. *Okoy*: sprouts fried with shredded green papaya and shrimps.

TABLE 5

Chemical composition of the sprouts at different stages in one set only

FIELD BEANS	VARIETY	CHEMICAL COMPONENTS	AVERAGE PERCENTAGES			
			At emergence of radicle	At emergence of radicle and plumule	At emergence of leaves folded	When leaves just open
Cadios, *Cajanus cajan*	Red	Moisture	51.01	70.25	79.4	82.62
		Fats	0.42	0.38	0.30	0.17
		Ash	2.50	2.36	2.06	1.12
		Protein	8.72	7.55	4.89	3.92
		Crude fiber	1.70	2.03	2.77	2.81
		C H O	35.65	17.43	10.58	9.36
		Calories per 100 gram	185.82	105.95	66.22	56.03
	Black	Moisture	54.39	75.69	92.21	92.93
		Fats	0.39	0.36	0.17	0.12
		Ash	1.63	1.41	0.63	0.60
		Protein	11.64	8.16	3.66	2.98
		Crude fiber	1.16	1.21	1.22	1.27
		C H O	30.79	13.17	2.11	2.03
		Calories per 100 gram	177.59	91.00	25.00	21.90
	Gray	Moisture	51.16	74.53	91.98	92.83
		Fats	0.48	0.29	0.30	0.16
		Ash	1.61	1.28	0.49	0.47
		Protein	2.31	6.50	3.66	3.04
		Crude fiber	0.69	0.97	1.35	1.36
		C H O	33.25	16.43	2.22	2.14
		Calories per 100 gram	191.26	97.00	27.00	22.73
Cowpea, *Vigna sinensis*	Kibal	Moisture	53.78	75.23	89.78	92.17
		Fats	0.30	0.28	0.25	0.13
		Ash	1.62	1.40	0.93	0.42
		Protein	11.09	8.96	5.75	3.88
		Crude fiber	0.82	0.89	0.98	1.42
		C H O	32.39	13.24	2.31	1.98
		Calories per 100 gram	181.06	93.62	25.37	25.24
	New Era	Moisture	54.15	75.52	91.02	92.13
		Fats	0.45	0.37	0.19	0.14
		Ash	1.74	1.35	0.52	0.49
		Protein	13.22	9.02	4.71	3.85
		Crude fiber	0.92	0.98	1.12	1.15
		C H O	29.52	12.76	2.44	2.24
		Calories per 100 gram	179.42	92.75	31.08	26.27

TABLE 5 (Continued)

FIELD BEANS	VARIETY	CHEMICAL COMPONENTS	AVERAGE PERCENTAGES			
			At emergence of radicle	At emergence of radicle and plumule	At emergence of leaves folded	When leaves just open
Mungo, *Phaseolus aureus*	Red	Moisture	52.98	75.73	91.38	92.43
		Fats	0.47	0.34	0.31	0.17
		Ash	1.65	1.42	0.61	0.46
		Protein	12.86	8.82	4.47	3.74
		Crude fiber	0.68	1.07	1.34	1.35
		C H O	31.36	12.62	1.89	1.85
		Calories per 100 gram	185.67	91.00	29.00	24.50
	Green	Moisture	51.23	74.42	90.82	91.35
		Fats	0.27	0.25	0.18	0.16
		Ash	1.93	1.45	0.58	0.42
		Protein	10.36	8.37	4.59	4.05
		Crude fiber	0.73	0.87	1.02	1.12
		C H O	35.48	14.64	2.81	2.90
		Calories per 100 gram	190.46	96.66	32.02	29.98
	Yellow	Moisture	53.08	74.95	90.58	91.23
		Fats	0.37	0.35	0.27	0.18
		Ash	1.15	1.03	0.49	0.45
		Protein	10.71	8.62	4.61	4.12
		Crude fiber	0.85	0.89	1.03	1.09
		C H O	33.84	14.16	3.02	2.93
		Calories per 100 gram	186.09	96.65	33.79	30.58
Patani, *Phaseolus lunatus*	Small, white-seeded	Moisture	52.97	70.32	84.36	86.02
		Fats	1.15	1.11	1.08	0.97
		Ash	1.53	1.45	1.36	1.34
		Protein	9.05	8.97	4.98	4.12
		Crude fiber	2.45	2.47	2.52	2.55
		C H O	32.85	15.68	5.70	5.00
		Calories per 100 gram	182.49	111.38	53.83	46.41
	Big, purple-seeded	Moisture	53.14	70.48	84.72	85.98
		Fats	1.16	1.14	1.10	0.98
		Ash	1.55	1.48	1.35	1.33
		Protein	9.12	9.01	5.07	4.28
		Crude fiber	2.50	2.53	2.57	2.58
		C H O	32.53	15.36	5.19	4.85
		Calories per 100 gram	181.55	110.52	52.30	46.57

TABLE 5 (Continued)

FIELD BEANS	VARIETY	CHEMICAL COMPONENTS	AVERAGE PERCENTAGES			
			At emergence of radicle	At emergence of radicle and plumule	At emergence of leaves folded	When leaves just open
Tapilan, *Phaseolus calcaratus*	White	Moisture	46.17	68.19	71.28	73.96
		Fats	0.43	0.39	0.40	0.37
		Ash	2.05	1.97	1.96	1.94
		Protein	3.98	3.21	3.02	2.98
		Crude fiber	2.82	2.84	2.86	2 88
		C H O	44.55	23.40	20.48	18.87
		Calories per 100 gram	202.57	112.73	100.07	93.03
Soybean, *Glycine max*	Green	Moisture	51.69	76.12	82.08	87.82
		Fats	1.34	1.13	0.68	0.54
		Ash	1.20	1.21	1.18	1.12
		Protein	23.13	10.93	8.79	5.98
		Crude fiber	0.75	0.87	1.11	1.26
		C H O	21.89	9.74	6.16	3 28
		Calories per 100 gram	197.04	95.26	67.62	42.99
	Yellow	Moisture	51.23	76.95	82.11	87.89
		Fats	1.28	1.09	0.70	0.56
		Ash	1.18	1.16	1.16	1.10
		Protein	18.85	10.01	8.97	6.02
		Crude fiber	0.65	0.85	1.09	1.19
		C H O	26.81	9.94	5.97	3.24
		Calories per 100 gram	199.11	91.93	67.76	43.07
Winged bean, *Psophocarpus tetragonolobus*		Moisture	58.64	78.23	90.16	92.37
		Fats	1.05	0.98	0.43	0.23
		Ash	2.33	2.29	2.11	1.98
		Protein	14.82	8.86	3.28	2.12
		Crude fiber	1.12	1.14	1.18	1.21
		C H O	22.04	8.50	2.84	2.09
		Calories per 100 gram	160.89	80.29	29.09	19.40

OBSERVATIONS ON THE INFLUENCE OF FIVE DIFFERENT KINDS OF LITTERS ON BROODING CHICKS[1]

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WITH TWO CHARTS

In the Philippines, the use of litter is not as common as elsewhere. The availability here of unlimited range for growing chicks probably makes its use not always necessary. Where the space is limited, however, some kind of a litter will be found necessary in the successful brooding of chicks. The question of what litter will be the best to use will then arise. The experiments here reported were conducted to throw some light on this subject.

This study was started in November, 1935, and ended in October, 1936. The experiments were conducted in the poultry laboratory, Department of Animal Husbandry.

Review of literature

Henderson, Whitfield, and Vernon (1933) recommended that all litters should be dry, clean, and free from fine dust or mold and that the litter should be changed whenever it becomes foul. They reported that clean, ground corncobs, shavings, chopped straw, sand, peat moss, and shredded corn stover have all been used as litters in brooding quarters with apparent success.

Rice and Botsford (1933) described an ideal litter as one which is durable, does not pack quickly, and has high absorptive power. They named, in the order of their desirability, straws of wheat, oat, rye, and buckwheat. Where straw is not available, according to these authors, shredded or cut cornstalks or shavings may be used. They also mentioned that straw or cut cornstalks mixed with shavings make a fluffy, loose litter.

Smith, Cooke, and White (1933) recommended that all hard floors should be covered with a layer of fine, clean sand, more or less heavy according to the frequency of removal, and on top of this a litter of fine cut straw or an equivalent should be added. They stated that the age or size of the chicks should determine the amount

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[1] Experiment Station contribution No. 1230.

of litter; the larger the chicks, the more the litter. The same authors recommended that sufficient cut straw be gradually added so that the chicks can scratch it about.

The materials that Goodearl (1934) recommended as best for litter are chopped alfalfa, chopped straw, shavings, and peat moss. He stressed the necessity of using only clean, bright, dry alfalfa and straw free from dust and dampness. He said that the litter must be free from any mold or mustiness. Goodearl stated, however, that where the poultrymen have eliminated litter from their brooder houses, they have used hardware cloth as a substitute. The wire is fastened to a framework, about 7.5 centimeters above the floor, and made into sections so that when fitted together the entire pen is completely covered. He also recommended that wire floors, just as litters, should be frequently cleaned, at least once a week.

Lippincott and Card (1934) recommended that, for artificial brooding of chicks, the floor beneath and surrounding the hover may be covered with a fine litter of some digestible material such as fine-cut alfalfa or clover. They said that this litter may be replaced with a less expensive one after the chicks are three to four weeks old. The same authors suggested that indigestible materials such as chaff, cut straw, and sand should be avoided for when the chicks fill themselves with them, these cause impaction and eventually a high death-rate.

PLAN OF THE STUDY

Los Baños Cantonese chicks, artificially hatched from eggs produced by the College flocks, were used in these experiments. There were three series of experiments of six lots each. In the first series, there were 26 chicks to a lot; in the second, 19; and in the third, 19; or a total of 384 chicks for the three series of experiments, with 64 chicks to each lot.

The different lots were treated as follows: lot I was provided with ¼-inch mesh woven wire flooring; lot II, sand; lot III, rice hulls; lot IV, rice straw; lot V, newspaper spread on the concrete floor and replaced frequently; and lot VI, bare conrete floor.

The wire flooring in lot I was elevated about 6.5 centimeters above the floor and attached to a detachable wooden framework to facilitate cleaning. The sand used in lot II was clean and free from shells. The rice hulls used in lot III were obtained from a rice mill in the barrio of San Antonio, Los Baños, Laguna. The rice straw used in lot IV was air-dry, and before it was placed in the brooding compartment, it was first cut into pieces of about 5 centimeters so that the chicks could scratch it freely. In lot V, the newspaper used was changed every morning. One layer was used at first, and as the chicks grew older, the number was increased to two. The concrete floor in lot VI was scraped and cleaned every morning.

The chicks were raised in fireless brooders placed in the brooding quarters in the poultry laboratory. The quarters were of the same measurements, about 1.20 meters long and 1.00 meter wide. The chicks were not allowed to leave their quarters while the experiments were in progress.

The College chick ration composed of 52.5 parts, by weight, of rice bran, 17.5 parts of corn meal, and 30.0 parts of fish meal was used in this study. As the chicks were raised indoors, 4 per cent cod liver oil was added to this ration. The feeds were given to the chicks in the form of dry mash. The feed troughs were kept open so that the chicks had free access to them at all times during the day. Water, changed from two to three times a day, was always accessible to the chicks. All lots were supplied with green feed, chopped fine. The chicks had access to all the grit and shells they needed.

After the chicks were removed from the incubator and leg-banded, they were weighed individually before being placed in the brooding quarters. They were weighed weekly thereafter for 12 weeks. The amount of feed consumed was recorded. Mortality records were also kept. Observations on the vigor of the chicks were made.

RESULTS AND DISCUSSION

Rate of growth of the chicks. The average rate of growth of the chicks in the different lots of the three series of experiments combined is presented in table 1, and the average final weights are graphically shown in chart 1. By reference to table 1, it may be seen that while at the beginning of the experiment the mean weight of one-day old chicks in all lots was more or less the same, differences began to be noticeable during the second week. At 4 weeks of age the chicks in lot III, rice-hull lot, had the highest mean weight, and those in lot V, newspaper lot, had the lowest. At 8 weeks the chicks in lot III, rice-hull lot, were still the heaviest, but those in lot VI, bare concrete lot, were the smallest. It may be noted in chart 1, however, that at the age of twelve weeks, the chicks in lot III, rice-hull lot, were the heaviest and those in lot V, newspaper lot, the lightest.

When lot I, wire flooring lot, was compared with lots II, sand lot, V, newspaper lot, and VI, bare concrete lot, there were significant differences, but when compared with lots III, rice-hull lot, and IV, rice-straw lot, the differences were not significant. There were also significant differences when lot II was compared with lots III, IV, V, and VI; when lot III was compared with lots V and VI; when lot IV was compared with lots V and VI; and when lot V was compared with lot VI. The difference between lots III and IV was not significant.

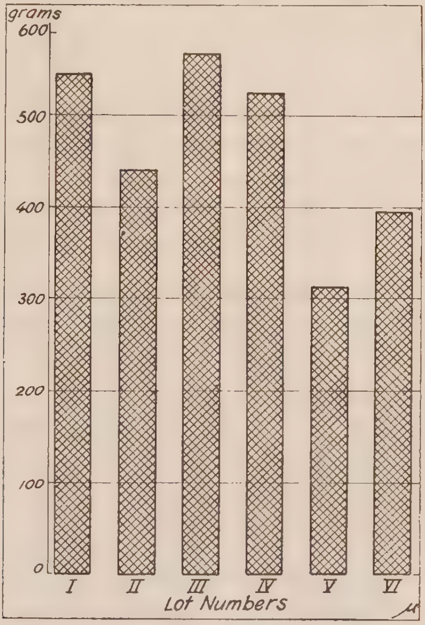

Chart 1.—Showing the average weights of the chicks in the different lots at the age of twelve weeks

With the final weight of the chicks in lot III, rice-hull lot, considered as 100 per cent, that of lot I, wire flooring lot, was 96.26; lot II, sand lot, 77.58; lot IV, rice straw lot, 92.36; lot V, newspaper lot, 54.98; and lot VI, bare concrete lot, 69.53.

Vigor of the chicks. The chicks in all lots were fairly active from their first day in the brooding quarters. In all the trials studied, all chicks suffered from cold; those in lot VI, bare concrete lot, suffered the most, and those in lot III, rice-hull lot, the least. During the seventh week, leg-weakness was noted in lots I and VI. According to Ufford (1933), the occurrence of leg-weakness may be induced by confining chicks too long on a board or cement floor without their being able to get out on the ground and by brooding them under window glass and thus preventing them from having access to direct rays of the sun.

In all the three trials made, the chicks in lot III, rice-hull lot, and lot IV, rice straw lot, were observed to be the most active and the wildest. The chicks in lot I, wire flooring lot, and those in lot VI, bare concrete lot, were very tame and rather inactive. During the eleventh week, some of the chicks in these lots lost weight. They appeared sickly as the face, wattles, and comb were very pale.

The chicks in lot III, rice-hull lot, were uniform in size as well as in the completeness of feathering. In lot IV, rice straw lot, the chicks were also uniform, but some were sparingly feathered. The chicks in lots I, wire flooring lot, II, sand lot, V, newspaper lot, and VI, bare concrete lot, were not uniform in size and in the rate of feathering. The chicks in lot III had glossy, shiny feathers, while those in the rest of the lots had dirty feathers; the lot VI, bare concrete lot, chicks had the dirtiest feathers.

Mortality of the chicks. In all the three trials of experiments studied (table 2 and chart 2), the percentage of mortality was almost consistently low in lot III, rice-hull lot, and high in lot V, newspaper lot. In the separate trials made, lot III twice ranked as lowest in mortality and once as second, and lot IV, rice straw lot, twice ranked as second and once as first. Lot II, sand lot, was highest in percentage of mortality in the first set and lot V, newspaper lot, in the last two sets. From the average for the three series studied, lot III, rice-hull lot, had the lowest and lot V, newspaper lot, the highest percentage of mortality.

These results show that lot III (rice-hull lot) had the lowest mortality of all the lots under study. With this lot as a basis for comparison, it was observed that the differences between the average mortality of this lot and those of all the other lots, except that of lot IV (rice straw lot), were significant. The difference between the average mortality of lot I (wire lot) and that of lot VI (bare concrete lot), two comparable lots, was, however, not significant, but the differences between the other comparable lots, lots II (sand lot) and III (rice-hull lot) and lots IV (rice-straw lot) and V (newspaper lot), were all significant. The differences, however, between lot I and lots II, IV, V, and VI, and between lot II and lots IV, V, and VI were not significant. There were significant differences between lot IV and lot V and between lot V and lot VI.

The low percentage of mortality in lot III, rice-hull lot, may be attributed in part to the kind of litter used. During the progress of this experiment there was never a time when the litter was observed to be moist. It absorbed the voidings and never became clumped and caked. Besides this, the chicks were always busy scratching it. In lot II, sand lot, the sand became packed very readily. The chicks scratched it only in some localized portions and only the surface became loose. As soon as the sand became mixed with the feces and part of the water was spilled from the drinking trough, the litter became packed. It was found necessary to turn

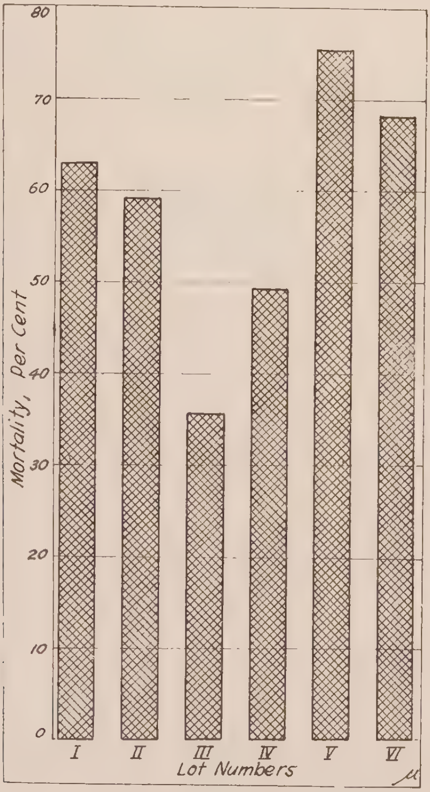

Chart 2.—Showing the average percentage of mortality in the different lots

up the sand frequently to loosen it, but in only a few minutes it became packed again.

In lot IV, rice-straw lot, the looseness of the litter was observed to last only for about a week or so, depending upon the age of the chicks. The litter became packed, moist, and produced a foul smell. It was turned to loosen it, but when mixed with the feces, it easily became packed again.

In lot I, wire flooring lot, and lot VI, bare concrete lot, the percentages of mortality were almost the same although slightly higher in lot VI. The chicks from both lots were vigorous and uniform up to the seventh week. Later, some of the chicks in these lots suffered from leg weakness and died.

In lot V, newspaper lot, the percentage of mortality was highest. This may be attributed to the litter used. It is worthy to note, however, that the greatest death-rate recorded was from the second week up to the sixth, as was the case in all other lots, although mortality in those lots was not as heavy as that in lot V.

Feed consumption and cost. The data obtained in this study regarding the amount of feeds consumed showed that the amount in lot I, wire flooring lot, was 72.68 kilograms; lot II, sand lot, 69.00; lot III, rice-hull lot, 116.03; lot IV, rice straw lot, 82.46; lot V, newspaper lot, 54.72; and lot VI, bare concrete lot, 57.0. It may be seen, by reference to table 3, that the average actual feed consumption per bird (up to 12 weeks) in lot I, wire flooring lot, was 3.16 kilogram in lot II, sand lot, 2.76; in lot III, rice-hull lot, 2.83; in lot IV, rice straw lot, 2.66; in lot V, newspaper lot, 3.42; and in lot VI, bare concrete lot, 2.88.

It was observed that as soon as the lot III chicks, rice-hull lot, were put in their rearing quarters, they began picking something from their litter. When they were about a week old, they became more busy scratching the litter and from then on continued scratching it. From a physical analysis of 10 kilograms of rice hulls which were divided into 10 samples of 1 kilogram each, and separated into three different fractions, such as fraction I, 5 mm.; fraction II, 3 mm.; and fraction III, 0.5 mm. (table 4), it was found that broken kernels and undeveloped grains were present in fraction II. To determine the amount of these grains that the chicks were able to consume from the litter, fraction II was further divided into fraction II-A and fraction II-B.

A careful identification of the three fractions contained the following:

Fraction I—rice hulls only
Fraction II-A—hulls intact, glumes intact, or fragments and few broken endosperm and embryos
Fraction II-B—broken or whole immature caryopses, broken mature endosperm with or without embryos, and some large pieces of hulls and glumes
Fraction III—small fragments of stigma, pollen grains, hair, hulls and glumes or glume proper, and minute broken endosperm and embryos from mature and immature kernels

Fraction II-B, which contained rich and nutritious feed in the rice hulls, when calculated gave a total weight of 0.0176 kgm. in the 10 kgm. of rice hulls studied, or 1.76 per cent. The 10-kgm. rice hulls, which was about the amount of litter used at a time, contained about 0.18 kgm. of these edible ingredients. In each trial, however, the litter was changed 3 times so that the chicks were able to obtain about 0.53 kgm. of these edible ingredients. This amount was probably consumed but was not actually recorded. This may be one of the reasons why the lot III chicks (rice-hull lot) ranked fourth place only in feed consumption.

From the average feed consumption per bird and from the number of weanlings that may be produced from 100 baby chicks, the total amount of feed consumed by each lot was determined. The price charged per kilogram of the ration used in this study was ₱0.06. It will be seen, by reference to table 3, that the total cost of feeds chargeable to each lot varied from ₱5.34 in lot V (newspaper lot) to ₱10.87 in lot III (rice-hull lot). Two factors were responsible for this variation in the total cost of feeds consumed by each lot—the average feed consumption per bird and the number of weanlings that was raised from 100 baby chicks.

At ₱0.60 a kilogram live weight and with the average weight of the weanlings, at the close of the experiment (see table 1), the total value of the weanlings produced from each lot was determined. The total value of the weanlings produced in each lot would naturally vary as not only the number but also the average weight of the weanlings produced in each lot were different. The income derived from the sale of the weanlings was highest in lot III (rice-hull lot), ₱21.77, and lowest in lot V (newspaper lot), ₱4.86.

The last column of table 3 shows the returns that would be derived from the sale of the weanlings after deducting the cost of feeds consumed. Based upon these figures, lot III (rice-hull lot) is undoubtedly the best, followed by lot IV (rice straw lot). Lot V (newspaper lot) is the poorest of the lots studied; instead of an income, there was a loss of ₱0.48 from this lot. The weanlings produced in this lot were the smallest and, at the same time, this lot recorded the highest mortality and the highest in average feed consumption. Although the weanlings produced in lot IV (rice straw lot) only ranked third in average weight, the mortality of the birds in this lot was second to that of lot III (rice-hull lot), and it recorded the smallest feed consumption per bird. This made the returns over the feed cost of this lot higher than that of lot I (wire lot) where the weanlings ranked second in average weight, fourth in mortality, and second in the average feed consumption per bird.

SUMMARY AND CONCLUSIONS

The results obtained from this study to determine the influence of five different kinds of litters on brooding chicks may be summarized as follows:

1. With the final mean weight as basis for comparison, lot III, rice-hull lot, was first; lot I, wire flooring lot, second; lot IV, rice straw lot, third; lot II, sand lot, fourth; lot VI, bare concrete lot, fifth; and lot V, newspaper lot, last.
2. The average feed consumption per bird was: lot I, wire flooring lot, 3.16 kilograms; lot II, sand lot, 2.76; lot III, rice-hull lot, 2.88; lot IV, rice straw lot, 2.66; lot V, newspaper lot, 3.42; and lot VI, bare concrete lot, 2.88.
3. The percentage of mortality was highest in lot V, newspaper lot, and lowest in lot III, rice-hull lot.
4. When the efficiency of the five different kinds of litters used, based on the weight of the chicks at 12 weeks of age and with the heaviest as 100 per cent, was considered, the different lots were: lot I, wire flooring lot, 96.26 per cent; lot II, sand lot, 77.58; lot III, rice-hull lot, 100; lot IV, rice straw lot, 92.36; lot V, newspaper lot, 54.98; and lot VI, bare concrete lot, 69.53.
5. Among the five different kinds of litters studied rice hull was found to be best, and newspaper, the poorest.
6. With economy and the rate of gain as a criterion for the efficiency of the litters used, lot III, rice-hull lot, was the most efficient; lot IV, rice straw lot, second; lot I, wire flooring lot, third; lot II, sand lot, fourth; lot VI, bare concrete lot, fifth; and lot V, newspaper lot, the least.

7. With reference to vigor and uniformity, lot III, rice-hull lot, was first and lot V, newspaper lot, last.

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TABLE 1

Mean weights of the chicks during the first twelve weeks after hatching.

AGE	LOT I WIRE FLOORING		LOT II SAND		LOT III RICE HULLS	
	No. of chicks	Weight	No. of chicks	Weight	No. of chicks	Weight
		grams		*grams*		*grams*
One day old	64	27.7± 0.240	64	27.6± 0.255	64	26.8± 0.268
1 week old	56	36.8± 0.417	58	32.6± 0.464	60	36.1± 0.464
2 weeks old	51	54.5± 0.817	53	51.5± 0.797	59	48.0± 0.754
3 weeks old	48	63.1± 1.488	50	69.1± 1.464	58	65.8± 1.688
4 weeks old	47	79.8± 2.353	41	78.9± 1.855	55	85.7± 2.321
5 weeks old	40	113.5± 3.490	36	91.1± 3.148	50	115.3± 2.996
6 weeks old	34	153.9± 5.125	34	121.9± 4.142	45	115.4± 4.178
7 weeks old	32	228.2± 7.181	31	153.8± 6.005	44	238.2± 5.295
8 weeks old	29	290.6± 8.931	31	199.9± 9.151	44	309.3± 6.905
9 weeks old	28	348.2±10.916	26	265.4±10.893	43	354.7± 8.588
10 weeks old	27	394.6±13.763	25	362.6±13.436	43	426.6± 9.978
11 weeks old	23	487.4±15.968	25	397.2±15.014	42	502.7±10.289
12 weeks old	23	545.7±17.869	25	439.8±17.443	41	566.9±11.098

TABLE 1 (Continued)

AGE	LOT IV RICE STRAW		LOT V NEWSPAPER		LOT VI BARE (CONCRETE)	
	No. of chicks	Weight	No. of chicks	Weight	No. of chicks	Weight
		grams		*grams*		*grams*
One day old	64	27.2± 0.307	74	27.2± 0.239	64	26.9± 0.252
1 week old	57	35.3± 0.482	54	35.2± 0.537	56	33.4± 0.458
2 weeks old	56	50.4± 0.915	47	49.0± 0.827	52	41.5± 0.660
3 weeks old	54	69.4± 1.321	43	51.7± 1.452	51	48.1± 1.186
4 weeks old	48	78.8± 2.027	35	64.7± 2.465	41	73.5± 1.908
5 weeks old	37	107.7± 2.685	31	70.9± 3.373	37	76.9± 3.217
6 weeks old	35	114.1± 3.629	26	75.7± 6.811	31	113.6± 5.192
7 weeks old	33	183.4± 6.809	22	89.4± 9.699	29	152.5± 6.294
8 weeks old	32	236.1± 6.971	20	216.6±10.593	28	179.4± 8.086
9 weeks old	31	297.1± 9.878	19	229.7±16.963	23	188.4±11.122
10 weeks old	31	371.6±10.554	19	214.7±23.491	22	336.4±14.328
11 weeks old	31	452.7±11.209	19	235.9±25.305	22	386.2±15.921
12 weeks old	31	523.6±13.866	16	311.7±26.660	20	394.2±17.292

TABLE 2

Percentage of mortality of the chicks during the first 12 weeks

LOT NO.	TREATMENT	TRIAL			AVERAGE
		1	2	3	
		per cent	*per cent*	*per cent*	*per cent*
I	Wire flooring	73.07	63.10	52.63	62.93 ± 3.978
II	Sand	76.92	47.37	52.63	58.97 ± 6.954
III	Rice hulls	38.46	36.84	31.57	35.62 ± 0.438
IV	Rice straw	69.23	31.57	47.36	49.38 ± 7.359
V	Newspaper	73.07	78.94	73.68	75.23 ± 1.335
VI	Bare concrete	73.07	68.42	63.10	68.19 ± 1.943

TABLE 3

Feed consumption, cost of chickens raised, and returns over feed cost (based upon 100 chicks)

LOT NO.	TREATMENT	NO. OF WEANLINGS RAISED	AVERAGE FEED CONSUMPTION PER BIRD	TOTAL FEED CONSUMED	COST OF FEED CONSUMED	AVERAGE WEIGHT PER BIRD	TOTAL WEIGHT OF WEANLINGS RAISED	TOTAL VALUE OF THE WEANLINGS	RETURNS OVER COST OF FEED
			kgm.	*kgm.*	*pesos*	*gm.*	*kgm.*	*pesos*	*pesos*
I	Wire flooring .	36	3.16	113.76	6.83	545.7	19.64	11.78	4.95
II	Sand	39	2.76	107.64	6.45	439.8	17.15	10.29	3.84
III	Rice hulls	64	2.83	181.12	10.87	566.9	36.28	21.77	10.90
IV	Rice straw	48	2.66	127.68	7.66	523.6	25.13	15.08	7.42
V	Newspaper ...	26	3.42	88.92	5.34	311.7	8.10	4.86	−0.48
VI	Bare (concrete)	31	2.88	89.28	5.36	394.2	12.22	7.33	1.97

TABLE 4

Physical analysis of the rice hulls when separated into three different fractions and the grains of fraction two separated into two sections

SAMPLES	I (5 MM.)	II (3 MM.)		III (0.5 MM.)	TOTAL	I (5 MM.)	II (3 MM.)		III (0.5 MM.)
		II-A	II-B				II-A	II-B	
	Rice hulls	Hulls and glumes intact, broken endosperm, and embryos	Broken or whole immature caryopses, endosperm, and pieces of hulls and glumes	Stigma, pollen grains, hair, hulls, glumes, broken endosperm, and embryos		Rice hulls	Hulls and glumes intact, broken endosperm, and embryos	Broken or whole immature caryopses, endosperm, and pieces of hulls and glumes	Stigma, pollen grains, hair, hulls, glumes, broken endosperm, and embryos
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*per cent*	*per cent*	*per cent*
1	0.9380	0.0460	0.0090	0.0070	1.0000	93.80	4.60	0.90	0.70
2	0.9305	0.0520	0.0090	0.0085	1.0000	93.05	5.20	0.90	0.85
3	0.9300	0.0515	0.0100	0.0085	1.0000	93.00	5.15	1.00	0.85
4	0.9420	0.0390	0.0110	0.0080	1.0000	94.20	3.90	1.10	0.80
5	0.8390	0.0880	0.0370	0.0360	1.0000	83.90	8.80	3.70	3.60
6	0.9570	0.0260	0.0100	0.0070	1.0000	95.70	2.50	1.00	0.70
7	0.8900	0.0600	0.0250	0.0250	1.0000	89.00	6.00	2.50	2.50
8	0.9490	0.0315	0.0100	0.0095	1.0000	94.90	3.15	1.00	0.90
9	0.9445	0.0380	0.0100	0.0075	1.0000	94.45	3.80	1.00	0.75
10	0.8240	0.0900	0.0450	0.0410	1.0000	82.40	9.00	4.50	4.10
Average	0.9144	0.0512	0.0176	0.0158	10.0000	91.44	5.12	1.76	1.58

A COMPARATIVE STUDY OF THE FEEDING VALUE OF "KISKIS" RICE BRAN AND "CONO" RICE BRAN FOR FATTENING SHOTES [1]

GUILLERMO D. VALDEZ

Tirol [2], experimenting on the feeding value of coarse rice bran as compared with fine rice bran for growing pigs from two to seven months old, reported that a ration containing 60 per cent coarse rice bran was only 38 per cent as efficient as a ration containing 60 per cent fine rice bran. The ration that contained 30 per cent each of fine and of coarse rice bran was found to be 67 per cent as good as that containing 60 per cent fine rice bran. From the standpoint of feed cost per kilogram gain, however, the ration containing coarse rice bran was found to cost 92 per cent more than the fine rice bran ration. The ration containing fine and coarse rice bran in equal proportions was found to cost 29 per cent more than the fine rice bran ration.

Rivera [3] conducted an experiment to determine whether it would be profitable to replace part of the fine rice bran contained in the College standard swine ration with coarse rice bran. Coarse rice bran is sold usually in the open market at about one third the price of fine rice bran. In this study, Rivera used three lots of pigs ten weeks old and carried them for a period of 210 days. Lot I pigs were fed the College standard ration containing 60 parts, or 60 per cent, of fine rice bran. In lot II pigs, the ration contained only 30 parts fine rice bran; thus in total quantity it was only 70 per cent of the rations given lots I and III. Lot III pigs were given 30 parts fine rice bran and 30 parts coarse rice bran, all by weight. He found that lot I made an average daily gain of 0.34 kilogram, lot II, 0.23 kilogram, and lot III, 0.26 kilogram, showing that the ration of lot III pigs was 76 per cent as efficient as that of lot I pigs and the ration of lot II pigs, which was 30 parts short in rice bran, was only 68 per cent efficient. This shows that some benefit had been obtained from the coarse rice bran. He attributed this to the 12 parts of fine rice bran normally contained in 30 parts of coarse rice bran, inasmuch as coarse rice bran contains approximately 60 per cent hulls and 40 per cent true bran.

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[1] Experiment Station contribution No. 1231. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor Mariano Mondoñedo.

[2] TIROL, ROBERTO H. 1932. Comparative feeding value of coarse and standard rice bran for growing pigs. The Philippine Agriculturist 21: 628-638.

[3] RIVERA, TEOFILO B. 1936. A study of the comparative feeding value for growing pigs of coarse and fine rice bran. The Philippine Agriculturist 24: 863–871.

Objects of the present work

The objects of this study were: (*a*) to determine whether or not coarse rice bran can be used to replace half of the amount of fine rice bran in the standard ration of older pigs, for example, market pigs eight months old, and (*b*) to determine whether coarse rice bran can be used for the same class of pigs to the exclusion of fine rice bran.

Time and place of the experiment

The work was conducted in the Department of Animal Husbandry. It consisted of three sets of experiments. The first set, designated as experiment I, was begun on December 1, 1934, and closed on February 8, 1935. The second, experiment II, was begun on January 26, 1935, and closed on April 6, 1935. The third, experiment III, was begun on September 29, 1935, and closed on December 8, 1935. Each feeding trial covered a period of 70 days.

MATERIALS AND METHODS

Animals used. Fifty-four Berkjala shotes eight to eleven months old, consisting of twenty-one barrows and thirty-three gilts, were used in the experiments. It was the plan to use fifteen shotes in each of the three sets of experiments. The third set, however, had to be discontinued because of the outbreak of hog cholera which occurred a few weeks after the third set of experiments had been started. After quarantine measures had been lifted, a fourth set of experiments was started on September 29, 1935, in place of the third set that was discontinued. This will hereafter be referred to as the third set. Although there were only nine pigs available for this set, it was thought best to carry out the test in order to complete the series of experiments as outlined. The last test was but a replication of the first two experiments.

Feeds used. The feeds used were shelled corn, coarse rice bran, fine rice bean, copra meal, and fish meal. The ration mixtures used were as follows:

FEEDS	LOT I	LOT II	LOT III
	parts	*parts*	*parts*
Fine rice bran	60	30	0
Coarse rice bran	0	30	60
Shelled corn	25	25	25
Copra meal	13	13	13
Fish meal	2	2	2
Total	100	100	100

The average prices of the feeds used at the time of the feeding trials were:

Shelled corn	7.2 centavos a kgm.
Fine rice bran	2.8 " " "
Coarse rice bran	1.1 " " "
Copra meal	3.5 " " "
Fish meal	11.0 " " "

Following is the chemical composition of fine rice bran and coarse rice bran as analyzed in the Department of Agricultural Chemistry:

CONSTITUENTS	FINE RICE BRAN	COARSE RICE BRAN
	per cent	*per cent*
Moisture	9.20	10.27
Fats (ether extract)	13.89	4.26
Ash	10.11	15.86
Protein (N. × 6.25)	12.38	5.41
Carbohydrates (N.F.E.)	44.70	38.63
Crude fiber	9.72	25.57

Mineral mixture used. To every 100 kgm. of the ration mixtures used, one kilogram of equal parts of common salt and ground corn-cob charcoal was added.

Allotment of pigs. There were three lots of pigs in each of the three experiments conducted. The pigs used were fairly uniform in size, weight, sex, and condition and were about eight months old at the beginning of the experiment.

Lot I pigs were designated as the control lot and received the College standard ration containing 60 per cent fine rice bran. Lot II pigs received 30 per cent fine and 30 per cent coarse rice bran in the ration, and lot III pigs received the 60 per cent coarse rice bran ration.

Feeding. The pigs were hand-fed twice daily, between 5:00 and 6:00 o'clock a. m. and between 5:00 and 6:00 o'clock p. m. They were allowed to eat as much as they could readily consume.

Weighing. Before being fed the pigs were weighed individually every Saturday between 3:00 and 4:00 p. m. The initial and final weights were taken in the usual manner. The pigs were bathed to remove any mud sticking to the body, but were allowed to dry off before they were weighed.

Care and management

During the whole period of each feeding trial, the pigs after each feeding were driven into a paddock bare of vegetation. In this inclosure, the pigs under normal conditions received sufficient shelter from the shade of an acacia tree growing on one side of the inclosure. The animals were fed in the hog house to which they were driven each feeding time. During inclement weather, however, the pigs were kept in the hog house at night.

Practically the same feeding and care were given to the pigs in all the lots of the three sets of experiments conducted.

Observations

Lot I (fine rice bran lot). The pigs in this lot in all of the three sets of experiments were healthy and remained in good condition throughout. They were low set and smooth looking. Compared with the other two lots of pigs, lot I pigs were able to consume all they cared to eat in a shorter time.

Lot II (fine-coarse rice bran lot). The pigs in this lot stood intermediate between lots I and III, but were closer to lot I pigs as to condition, form, and quality, as well as in time required to consume the feed they cared to eat.

Lot III (coarse rice bran lot). The pigs in this lot were observed not to relish their feed at the beginning of each period. But when they became used to it, they ate their ration quite readily. Compared with the other two lots, however, the pigs in this lot took the longest time to eat. They developed coarser hair than the pigs in lots I and II, and were rather rangy and spare in condition.

RESULTS

For convenience in discussion, the results reported are summarized in the following tabulation:

Average daily gain in weight per pig

EXPERIMENTS	LOT I FINE RICE BRAN	LOT II FINE-COARSE RICE BRAN	LOT III COARSE RICE BRAN
	kgm.	*kgm.*	*kgm.*
I	0.36	0.38	0.31
II	0.29	0.31	0.21
III	0.35	0.35	0.19
Average	0.33 ± 1.08	0.35 ± 1.08	0.24 ± 2.00

Feed consumed per kilogram gain

	kgm.	*kgm.*	*kgm.*
I	5.29	5.91	6.59
II	6.01	7.10	8.22
III	4.51	4.74	5.64
Average	5.25 ± 1.84	5.92 ± 5.82	6.82 ± 4.23

Cost of feed consumed per kilogram gain

	centavos	*centavos*	*centavos*
I	21.66	21.51	20.63
II	24.94	25.84	25.73
III	18.72	17.25	17.65
Average	21.77	21.53	21.37

DISCUSSION OF RESULTS

The results obtained in all the experiments were so similar in all important respects, as may be seen in the tabulated summary of results, that the averages of these results may be used as the basis for discussion. For criteria of the results obtained, the rate of gain, the amount of feed consumed for a given unit of gain, and the cost of feed needed to make a unit gain in weight, were used as the measurements of the efficiency of the three ration mixtures under study. By reference to the table, it may be noted that in all the three experiments, lot II pigs, which received the combined fine-coarse rice bran ration, consistently made more rapid gains in weight than lot I pigs, which received the fine rice bran ration. The average difference was only 0.02 kgm. per day, but the consistency of the results obtained tended to show that the mixture of coarse and fine rice bran in equal proportions was slightly better than the fine rice bran ration. Lot III pigs, which received the coarse rice bran ration, consistently made the slowest gains.

With the average daily gain made by lot I in the three tests as the basis of comparison, it may be stated that the coarse rice bran ration was only 71 per cent as efficient as that of lot I, while the combined fine-coarse rice bran ration (lot II) was 6 per cent more efficient than the fine rice bran ration (lot I). This difference, however, when treated statistically is insignificant.

With the efficiency of the three ration mixtures used in this study considered from the point of view of the amount of feed consumed for a given unit of gain, it may be noted that lot I pigs fed the fine rice bran ration, required the least amount of feed to make a given unit of gain. Lot III pigs, on the other hand, fed on the coarse rice bran ration, the most bulky feed mixture because of the presence of hulls, required the greatest amount of feed to make a given unit of gain. Lot II pigs, which were fed with the combined fine-coarse rice bran ration, stood intermediate between the two lots.

It seems evident from these results that the coarse rice bran in the combined ration was better utilized by lot II pigs than the fine rice bran by lot I pigs. Lot II pigs consumed 5.92 kgm. feed to make a kilogram gain. Of this amount, 30 per cent, or 1.78 kgm., was coarse rice bran which contains 60 per cent, or 1.07 kgm., hulls. With the hulls excluded, therefore, the pigs consumed only 4.85 kgm. feed to make a kilogram gain, without affecting adversely the rate of gain, while lot I pigs consumed 5.25 kgm. feed for the same unit of gain. With the hulls also excluded from the coarse rice bran ration of lot III, the pigs consumed only 4.37 kgm. of feed for a kilogram gain, showing that the greatest economy in feed per unit of gain was secured in this lot, but at the expense of rate of gain which was greatly retarded.

From the point of view of the cost of feed consumed to make a given unit of gain, the results were not consistent, although the averages show that the coarse rice bran ration was slightly the cheapest. The average in all for the three sets of experiments was 21.77 centavos for lot I, 21.53 centavos for lot II, and 21.37 centavos for lot III.

The slightly higher cost of feed in lot I was due largely to the fact that the market price of rice bran during the time the experiment was conducted was 2.8 centavos a kgm., while coarse rice bran was only 1.1 centavos a kgm. The ration mixture of lot I cost 4.15

centavos a kgm., lot II, 3.64 centavos a kgm., and lot III, 3.13 centavos a kgm.

It appears from these results that the replacement of half the amount of fine rice bran in the standard ration with an equal amount by weight of coarse rice bran gave beneficial results, attributable probably not only to the fine rice bran which the coarse rice bran contained, as found by Rivera, but apparently also to the coarse rice bran itself. The findings of Rivera apply to the feeding of young pigs about two and a half months old for a period of 210 days. The fact that both Tirol and Rivera found coarse rice bran to have greater feeding value for older pigs than for younger ones indicates that the hulls in the coarse rice bran have some feed value for older pigs. Rivera and Tirol believed the hulls in the coarse rice bran were responsible for the poor showing of young pigs fed on the coarse rice bran ration, but these hulls were found to be beneficial to the older pigs used in these experiments. Therefore, for pigs eight months old or older, according to the present results, some coarse rice bran may be safely substituted for fine rice bran, probably so long as the ratio does not exceed 30 per cent of the whole ration.

Rice hulls even when finely ground are generally regarded as having little or no feeding value. How then may we reconcile the findings that they have deleterious effects on young pigs and beneficial effects on older ones? It is common knowledge that young pigs require more concentrated or digestible feeds than old ones. As the pigs grow older, their ability to digest feed is apparently improved.

SUMMARY AND CONCLUSIONS

1. With the efficiency of the two rations studied based on the average daily gain per pig, and the fine rice bran ration taken as 100 per cent, the ration containing equal proportions of fine and coarse rice bran was 6.05 per cent better than the fine rice bran ration. The coarse rice bran ration was only 70.94 per cent as good as the fine rice bran ration.

2. Calculations being based on the amount of feed consumed to make a kilogram gain, with the fine rice bran ration considered as 100 per cent, the ration containing fine and coarse rice bran in equal proportions was 89.37 per cent as efficient as the fine rice bran ration, and the coarse rice bran ration was only 77.38 per cent as good.

3. From the point of view of feed cost, the three rations were about the same in efficiency. To make one kilogram gain, lot I pigs consumed 21.77 centavos worth of feed; lot II, 21.53 centavos; and

lot III, 21.37 centavos. In this connection, one should consider the quality and finish of the pigs by lots. The fine rice bran ration turned out fine, smooth looking pigs; the coarse rice bran ration turned out coarse, rangy pigs, and the combined fine-coarse rice bran ration turned out pigs that were intermediate, but closely similar to the pigs on the fine rice bran ration.

4. The results obtained from this study indicate that for pigs at the age of eight to eleven months, coarse rice bran may be used to advantage to replace one-half of the fine rice bran in the standard ration.

5. It does not appear advisable, however to substitute wholly coarse rice bran for the fine rice bran of the standard ration, because the rate of gain was markedly retarded and the quality of the pigs was adversely affected.

A STUDY OF THE YIELD OF SOILAGE OF P.S.A. 14 SUGAR CANE RATOON AND CONSUMPTION BY CATTLE OF CROP CUT AT DIFFERENT AGES[1]

DOROTEO FERNANDO TINIO

To supply work animals with a sufficient amount of forage is a problem in sugar cane plantations. Sometimes large areas of land are allowed to fallow every year. It would be of interest to the sugar farmer to find out if the ratoon crop of fallowed lands could be utilized for feeding purposes; hence, this study was undertaken.

Review of literature

Guthrie (1902) stated that stock greatly relished cane, and that cattle did extremely well with it although it was fed without cutting or chopping.

According to Shorey (1906), sugar cane tops exceeded many times all other green fodders combined as feed for livestock in Honolulu. He also said that cane tops were a regular ration for stock on or in the vicinity of the plantations.

Westgate (1915) reported that the yield of cane tops per acre was about 10 per cent of the weight of the usable cane. He stated further that on unirrigated plantations the yield was from four to eight tons per acre, or an average of about fifteen tons per hectare.

Ward and Ray (1916) found that in Cuba and Porto Rico the thousands of work oxen and horses were fed very largely upon sugar cane, of which they ate the entire stalk and leaves.

Esguerra and Sarao (1934) reported that, according to Dr. V. C. Calma, a hectare of sugar cane crop in the College of Agriculture yields, on the average, a little over ten tons of tops after the points for planting have been removed. They stated that there is an abundance of cane tops during the brief harvest season, but only a very small portion can be utilized for immediate feeding.

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[1] Experiment Station contribution No. 1232. Prepared in the Departments of Agronomy and Animal Husbandry under the direction of Drs. Valeriano C. Calma and Valente Villegas.

Objects of the present work

The objects of the present study were: (*a*) to determine the yield as soilage for cattle at different ages of cutting of the ratoon crop of P.S.A. 14 sugar cane, (*b*) to determine the consumption and left-over by cattle of the same soilage, and (*c*) to compare the proximate constituents of the above-mentioned material at different ages of cutting.

Time and place of the present work

The work was carried out from June, 1936, to February, 1937. The ratoon crop of sugar cane was grown at the Experiment Station field of the College of Agriculture. The consumption trials were run at the Department of Animal Husbandry.

MATERIALS AND METHODS

Field. The field used in this work had an area of about 0.6 of a hectare. The soil was clay loam. The field was divided into four plots, A, B, C, and D, from which soilage of different ages used in this experiment were cut. The five-month old soilage, first cutting, which was grown from March 19 to August 19 to 28, 1936, and the two-month-old, second cutting, which was grown from August 19 to 28 to October 30 to November 3, 1936, were obtained from plot A. The first cuttings from plots B, C, and D were used in the preliminary feeding trials to determine the feed capacity of the animals. The five-month-old, second cutting, which was grown from June 28 to July 7, to November 29 to December 8, 1936, was obtained from plot B; the three-month-old, second cutting, which was grown from June 28 to July 7 to September 28 to October 7, 1936, and the four-month-old, third cutting, which was grown from September 28 to October 7, 1936, to January 29 to February 7, 1937, were obtained from plot C; the four-month-old, second cutting, which was grown from June 20 to 29 to October 20 to 29, 1936, and the three-month-old, third cutting, which was grown from October 20 to 29, 1936, to January 20 to 29, 1937, were obtained from plot D.

Sugar cane ratoon crop. Ratoon of P.S.A. 14 sugar cane was used. The original seed pieces from which the ratoon plants grew were planted on February 15 to 18, 1935; the crop was harvested on January 29-30, 1936; and the trash was burned on March 9, 1936. Soilage of different ages were cut to determine the yields and consumption records by cattle. The five-month-old, first cutting crop was cut on August 19 to 28, 1936; the two-month-old, second cutting crop, on October 30 to November 3, 1936; the three-month-old, second cutting on September 28 to October 7, 1936; the four-month-old, second cutting on October 20 to 29, 1936; the five-month-old, second cutting, on November 29 to December 8, 1936; the two-month-old, third cutting, on December 30, 1936; the three-month-old, third cutting, on January 19 to 28, 1937, and the four-month-old, third cutting, on January 29 to February 7, 1937. There was no trial feeding done in the two-month-old, third cutting, owing to inadequate amount of soilage produced.

Cattle. Five full-grown Philippine cows were used throughout in running the consumption tests. The cows bore herd numbers 174, 198, 215, 283, and 291. Their weights ranged from 244.1 kgm. for cow No. 283 to 277.7 kgm. for cow No. 291; the average was 266.1 kgm. The youngest of them was No. 283, about three years of age at the time the experiment was started, and the oldest was No. 174, 11 years of age.

Feed cutter. A feed cutter operated by hand was used in cutting the soilage into two-centimeter pieces.

Cultivation, weeding, and care of culture. After the sugar cane field was burned in March, 1936, the standing portions of the cane stalks were chopped down on March 19 to 21, 1936. The canes were off-barred and hilled-up alternately. On March 25 to 26, 1936, the first off-barring was done. On July 31, 1936, the canes were hilled-up for the first time. The canes were off-barred for the second time on August 31, 1936, and hilled-up on November 20 to 21, 1936.

Weeding with a hoe was done on June 21, July 9, August 3 to 5, 31, and October 28, 1936.

Determination of height and number of shoots. Fifty plants were taken at random and measured from the base to the tip of the longest leaf at the time of cutting. The number of shoots per stool at different ages was also determined. The number of plants in each of 50 stools was counted.

Harvesting and determination of yield. In harvesting, the shoots were cut with a scythe just above the surface of the ground. Harvesting was done in the afternoon for ten days during each feeding trial. The soilage was weighed soon after harvesting to determine the yield.

Chemical analysis. Fresh samples of the forage were taken from the field every feeding period. These were sliced and bottled for chemical analysis.

Preliminary feeding trial. The experimental animals were fed with sugar cane plants for a period of ten days to determine their capacity for this kind of feed. Enough of the forage was given so that they had all they could consume during the daytime. The average consumption record of each cow was used as the basis for feeding the sugar cane at different ages.

System of feeding. Feeding was done during the daytime. The morning feed was given at 6:00 a. m., the midday feed at 11:00 a.m., and the afternoon feed at 3:00 p.m. The weight of the feed given to each animal at these different times corresponded to the average consumption during the preliminary feeding trials. By 6:00 p.m. the left-over in the different boxes was weighed. The difference in weight between the amount given and the left-over represented the amount consumed. This figure is not exactly accurate as the loss in drying of the remaining portion is accounted for as part of the amount consumed. That a feed is more palatable than another was shown by the greater percentage of consumption and smaller percentage of left-over of that feed as compared with the other.

The animals were given water in the morning and in the afternoon. Salt was also given three times a week, a handful to each cow each time.

Weighing of animals. The experimental animals were weighed during the first and last three days of the feeding period to find out whether they were doing well on the feed they received.

RESULTS AND DISCUSSION

The results of this study are presented in tables 1 to 5.

Number of shoots per stool

Table 1 shows the number and height of shoots of P.S.A. 14 sugar cane cut at different ages. It will be seen in this table that with the five-month-old, first cutting crop, the average in the number of shoots per stool was 9.68. With the second cutting crops, the following results were obtained: The number of shoots per stool in the two-month-old crop was on the average 16.86; with the three-month-old crop, 10.86; with the four-month-old crop, 7.54; with the five-month-old crop, 7.06. With the third cutting crops, the average number of shoots per stool in the two-month-old crop was 13.40; in the three-month-old crop, 8.50; and in the four-month-old crop, 8.34.

It is very evident from the results just referred to that the younger the plant in a given cutting the greater the number of shoots per stool, and vice versa. This result may be attributed to the fact that the older the plants, the greater the amount of food nutrients they require; therefore, only a limited number of shoots could be taken care of by the older stools. Another reason that may be advanced for this result is that the older the plant in a given cutting, the longer it is exposed to adverse conditions, pests, and diseases, and hence, the more plants are likely to succumb.

The height of plants

The relative height of the shoots at different ages of cuttings is shown in table 1. It will be seen that the height of the five-month-old crop, first cutting, was on the average 219.47 cm. With the second cutting, the following results were obtained: The average height of the two-month-old crop was 109.56 cm.; of the three-month-old crop, 144.96 cm.; of the four-month-old crop, 201.96 cm.; and of the five-month-old crop, 207.82 cm. With the third cutting, the average height of the two-month-old crop was 91.94 cm.; of the three-month-old crop, 119.78 cm.; and of the four-month-old crop, 151.10 cm.

As a whole, the results showed that the older the plants in a given cutting, the taller were the cane plants, and vice versa. This is but natural to expect since the cane plants are given more time for vegetative growth. The result may also be accounted for by the fact that since it was found that the older the plant in a given cutting was, the less the number of tillers, any reserve food in the rhizomes of the cane and food nutrients in the soil must have been utilized for the maintenance of the remaining plants; hence, their more rapid growth.

The yield

Comparative yield of soilage of different ages from the same cutting. The yield of soilage of P.S.A. 14 sugar cane ratoon is presented in table 2. The five-month-old crop, first cutting, gave a computed yield of 29,880.93 kgm. per hectare. With the second cutting, the computed yield per hectare of two-month-old soilage was 7,308.10 kgm.; of the three-month-old soilage, 11,304.05 kgm.; of the four-month-old soilage, 13,449.38 kgm.; and of the five-month-old soilage, 15,650.72 kgm. In the third cutting, the following computed yields per hectare were obtained: The two-month-old soilage gave a yield of 5,060.24 kgm.; the three-month-old crop, 6,712.51 kgm.; and the four-month-old crop, 8,240.06 kgm.

In general, the results show that the older the soilage in a given cutting, the greater was the yield, and vice versa. These results are in harmony with the finding that the older the soilage in a given cutting was, the taller were the cane plants, and vice versa.

Comparative yield of soilage from different cuttings of the same age. When the yield of the same age of soilage from different cuttings was compared, it may be seen in table 2 that the five-month-old crop, first cutting, gave 90.92 per cent more yield than the five-month-old crop, second cutting. In the four-month-old crops, the second cutting gave 63.22 per cent more than the third cutting. In the three-month-old crops, the second cutting gave 68.40 per cent more yield than the third cutting. In the two-month-old crops, the second cutting gave 44.42 per cent more than the third cutting.

Villegas (1935), (1936) in his studies on Guinea grass and Napier grass, respectively, found that there was a tendency for the productivity of the field to decrease as the plants became older.

Amount of soilage consumed

Table 3 shows the average consumption by cattle of P.S.A. 14 sugar cane at different cuttings and ages. The average consumption of the five-month-old, first cutting, was 23.75 kgm. The percentage consumption was 91.00.

With the two-month-old, second cutting crop, the average consumption was 25.54 kgm. The average percentage consumption was 97.50.

With the three-month-old crop, second cutting, the average consumption was 25.05 kgm. The average percentage consumption was 95.35.

The consumption in the four-month-old crop, second cutting, was 24.07 kgm. The percentage consumption was on the average 91.86.

The average consumption in the five-month-old, second cutting crop, was 23.00 kgm. The average percentage consumption was 88.03. With the three-month-old, third cutting, the average consumption was 24.44 kgm. The average percentage consumption was 93.61.

With the four-month-old crop, third cutting, the average consumption was 23.62 kgm. The percentage consumption was on the average 90.44.

To summarize, it is clearly seen that the average consumption a day for each animal ranged from 23.00 kgm., or 88.03 per cent, with the five-month-old second cutting, to 25.54 kgm., or 97.50 per cent, with the two-month-old second cutting. This showed that the two-month-old second cutting was the most palatable, the three-month-old of the same cutting ranked second, and the three-month-old third cutting, third. The five-month-old first and second cuttings were the least palatable.

From a comparison of the average percentage consumption of the same age of soilage at different cuttings, there was less consumption as the crops grew older.

With regard to the amount of soilage which may be utilized by cattle from one hectare, that is, the yield per hectare multiplied by the average percentage consumption of different cuttings, the five-month-old of the first cutting was 27,191.65 kgm. and the five-month-old second cutting, 13,777.33 kgm. The crops having the least amount of consumable soilage per hectare were the three-month-old third cutting and the two-month-old second cutting, or 6,283.58 kgm. and 7,125.40 kgm., respectively.

Amount of left-over

Table 4 shows the average left-over by cattle of P.S.A. 14 sugar cane at different cuttings and ages. The average left-over of the five-month-old first cutting was 2.45 kgm., or 9.00 per cent.

With the two-month-old crop, second cutting, the amount of left-over was on the average 0.66 kgm., or 2.50 per cent.

With the three-month-old crop, second cutting, the average left-over was 1.15 kgm., or 4.65 per cent.

The average left-over of the four-month-old second cutting, was 2.13 kgm., or 8.14 per cent.

With the five-month-old second cutting, the average left-over was 3.20 kgm., or 11.97 per cent.

With the three-month-old third cutting, the average left-over was 1.76 kgm., or 6.39 per cent.

With the four-month-old third cutting, the average left-over was 2.58 kgm., or 9.56 per cent.

The amount of feed left over in the manger ranged from 0.66 kgm., or 2.50 per cent, with the two-month-old second cutting, to 3.20 kgm., or 11.97 per cent, with the five-month-old crop of the same cutting.

With the three-, four-, and five-month-old soilages, the cows were observed to eat all the leaves, leaf-sheaths, tender shoots, and a portion of the stalks. The left-over was composed mostly of nodes and internodes of the older cane. Only a few or none of the shoots of the two-month-old cane had nodes or internodes.

Weights of animals

Practically all the animals were benefited by the feed given to them in the different trials. The gains in weight per head daily ranged from an average of 0.47 kgm., with the four-month-old second cutting, to 2.27 kgm., with the two-month-old second cutting. The average was 1.31 kgm.

Chemical analysis [2]

The average proximate chemical analysis of P.S.A. 14 sugar cane at different ages is shown in table 5. From a comparison of the forages of the same age cut at different times, the results showed no definite trend, except in the amount of fat which was consistently greater in the later cuttings than in the preceding ones. It may be stated that the age of the plant as well as the time of the cutting had little influence on the composition of the plant. It is probable that the constituents present in the leaves when the forage was young were later distributed in the canes so that the composition remained about the same whether the plant was young or old within the ages when the plants under study were harvested. In fact, Deerr (1921) reported that in the very young parts of the cane stalk only starch is present, which is consumed little by little in the formation of cellulose.

The average composition of forage at all ages as reported in this paper is as follows: moisture, 79.11 per cent; fat, 0.47 per cent; ash, 2.08 per cent; protein, 1.25 per cent; crude fiber, 7.01 per cent; nitrogen-free-extract, 10.08 per cent. The average amount of calories per 100 grams of the sample was 50.71.

SUMMARY AND CONCLUSIONS

1. The two-month-old crop, second cutting, had the greatest average number of shoots which was 16.86 per stool. The five-month-old crop of the same cutting had the lowest number, or an average of 7.06 shoots. The older the canes in a given cutting, the less the number of shoots, and vice versa.

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[2] The chemical analysis was performed by Mrs. M. M. Ylagan, of the Department of Agricultural Chemistry, to whom the writer is greatly indebted.

2. The five-month-old first cutting, had the tallest plant, or an average height of 219.47 cm. and the two-month-old third cutting, the shortest, or an average height of 91.94 cm. The older the cane crop, the taller was the cane, and vice versa.

3. The computed yield per hectare ranged from 5,060.24 kgm., with the two-month-old third cutting, to 29,880.93 kgm., with the five-month-old first cutting. The older the forage in a given cutting, the higher was the yield obtained.

4. The greater the number of cuttings made, with the age of the plant under each cutting remaining the same, the lower the yield became, and vice versa.

5. The average amount of soilage consumed varied from 23.00 kgm., or 88.03 per cent, with the five-month-old, second cutting, to 25.54 kgm., or 97.50 per cent, with the two-month-old, of the same cutting. The younger the crop was in the given cutting, the greater the amount consumed.

6. From the standpoint of forage consumed per hectare, the five-month-old crop, first cutting, was found to give the highest amount of soilage consumed, and the three-month-old third cutting, the least.

7. The average amount of soilage left over by cattle ranged from 0.66 kgm., or 2.50 per cent, with the two-month-old second cutting, to 3.20 kgm., or 11.97 per cent, with the five-month-old crop of the same cutting.

8. The leaves, leaf-sheaths, and tender shoots were consumed on the whole. The left-overs in the mangers were generally portions of nodes and internodes.

9. Practically all the animals were benefited by the feed given to them in the different trials. The average gain in weight per head daily was 1.31 kgm.

10. The proximate chemical constituents of sugar cane tops showed no definite change trend, except fat which was consistently greater in the older plants. The age of the growth under each cutting as well as the number of times of cutting did not influence the composition of the forage. The composition remained about the same whether the forage studied was young or old. In view of this, the ratoon growth was available for feeding at all times within the limits of time covered by this study.

11. The average chemical analysis of the soilage follows: moisture, 79.11 per cent; fat, 0.47 per cent; ash, 2.08 per cent; protein,

1.25 per cent; crude fiber, 7.01 per cent; nitrogen-free-extract, 10.08 per cent. The average calories per 100 grams of the material was 50.71.

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TABLE 1

Number and height of shoots of P. S. A. 14 sugar cane soilage cut at different ages

CROP	NO. OF SHOOTS		HEIGHT	
	Range	Average	Range	Average
			cm.	*cm.*
First cutting:				
5-month-old	2–20	9.68	178–260	219.47
Second cutting:				
2-month-old	3–36	16.86	65–140	109.56
3-month-old	1–25	10.86	94–218	144.96
4-month-old	1–20	7.54	170–243	201.96
5-month-old	2–19	7.06	173–227	207.82
Third cutting:				
2-month-old	4–36	13.40	54–135	91.94
3-month-old	3–17	8.50	73–175	119.78
4-month-old	2–26	8.34	112–205	151.10

TABLE 2

Yield of soilage of P. S. A. 14 sugar cane ratoon crop cut at different ages

CROP	AREA OF PLOT	YIELD PER PLOT	COMPUTED YIELD PER HECTARE
	sq. m.	*kgm.*	*kgm.*
First cutting:			
5-month-old	1033.1	3087.0	29,880.93
Second cutting:			
2-month-old	1033.1	755.0	7,308.10
3-month-old	1680.8	1900.0	11,304.05
4-month-old	2052.9	2761.0	13,449.38
5-month-old	1141.8	1787.0	15,650.72
Third cutting:			
2-month-old	124.5	63.0	5,060.24
3-month-old	2052.9	1378.0	6,712.51
4-month-old	1680.8	1385.0	8,240.06

TABLE 3

Average consumption by cattle of P. S. A. 14 sugar cane soilage cut at different ages

ANIMAL NO.	FIRST CUTTING		SECOND CUTTING							
	5-month-old		2-month-old		3-month-old		4-month-old		5-month-old	
	Average	Per-centage	Average	Per-centage	Average	Per-centage	Average	Per-centage	Average	Per-centage
	kgm.		*kgm.*		*kgm.*		*kgm.*		*kgm.*	
174	26.99 ± 0.36	93.07	28.20 ± 0.05	97.24	28.73 ± 0.05	99.07	26.90 ± 0.24	92.76	24.69 ± 0.36	85.14
198	26.49 ± 0.24	92.92	28.68 ± 0.04	95.60	28.14 ± 0.27	93.80	27.83 ± 0.16	92.77	25.25 ± 0.39	84.17
215	22.69 ± 0.51	84.04	26.74 ± 0.06	99.04	26.06 ± 0.18	96.52	23.79 ± 0.26	88.11	24.36 ± 0.25	90.22
283	20.30 ± 0.13	96.67	20.10 ± 0.06	95.72	18.38 ± 0.35	87.52	19.21 ± 0.21	91.48	18.72 ± 0.17	89.14
291	22.30 ± 0.43	88.30	23.98 ± 0.01	99.92	23.96 ± 0.01	99.83	22.60 ± 0.20	94.17	21.96 ± 0.26	91.50
Gen. Average	23.75	91.00	25.54	97.50	25.05	95.35	24.07	91.86	23.00	88.03

ANIMAL NO.	THIRD CUTTING			
	3-month-old		4-month-old	
	Average	Per-centage	Average	Per-centage
	kgm.		*kgm.*	
174	25.77 ± 0.32	88.86	24.58 ± 0.38	84.76
198	26.74 ± 0.45	89.13	26.31 ± 0.25	87.70
215	26.33 ± 0.19	97.52	25.23 ± 0.28	93.45
283	19.84 ± 0.15	94.48	19.17 ± 0.16	91.29
291	23.53 ± 0.15	98.04	22.80 ± 0.15	95.00
Gen. Average	24.44	93.61	23.62	90.44

TABLE 4

Average amount of feed left over by cattle when given P. S. A. 14 sugar cane soilage cut at different ages

ANIMAL NO.	FIRST CUTTING		SECOND CUTTING							
	5-month-old		2-month-old		3-month-old		4-month-old		5-month-old	
	Average	Per-centage	Average	Per-centage	Average	Per-centage	Average	Per-centage	Average	Per-centage
	kgm.		*kgm.*		*kgm.*		*kgm.*		*kgm.*	
174	2.01 ± 0.36	6.95	0.80 ± 0.05	2.76	0.27 ± 0.05	0.93	2.10 ± 0.24	7.24	4.31 ± 0.36	14.86
198	3.51 ± 0.24	7.08	1.32 ± 0.04	4.40	1.86 ± 0.27	6.20	2.17 ± 0.16	7.23	4.75 ± 0.39	15.83
215	4.31 ± 0.51	15.96	0.26 ± 0.06	0.96	0.94 ± 0.18	3.48	3.21 ± 0.26	11.89	2.64 ± 0.25	9.78
283	0.70 ± 0.13	3.33	0.90 ± 0.06	4.28	2.62 ± 0.35	12.48	1.79 ± 0.21	8.52	2.28 ± 0.17	10.86
291	1.70 ± 0.43	11.70	0.02 ± 0.01	0.08	0.04 ± 0.01	0.17	1.40 ± 0.20	5.83	2.04 ± 0.26	8.50
Gen. Average	2.45	9.00	0.66	2.50	1.15	4.65	2.13	8.14	3.20	11.97

ANIMAL NO.	THIRD CUTTING			
	3-month-old		4-month-old	
	Average	Per-centage	Average	Per-centage
	kgm.		*kgm.*	
174	3.23 ± 0.32	11.14	4.42 ± 0.38	15.24
198	3.26 ± 0.45	10.87	3.69 ± 0.25	12.30
215	0.67 ± 0.19	2.48	1.77 ± 0.28	6.55
283	1.16 ± 0.15	5.52	1.83 ± 0.16	8.71
291	0.47 ± 0.15	1.96	1.20 ± 0.15	5.00
Gen. Average	1.76	6.39	2.58	9.56

TABLE 5

Proximate constituents of P. S. A. 14 sugar cane soilage cut at different ages

	5-MONTH-OLD		4-MONTH-OLD		3-MONTH-OLD		2-MONTH-OLD	AVERAGE
	First cutting	Second cutting	Second cutting	Third cutting	Second cutting	Third cutting	Second cutting	
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Moisture	81.19	79.76	79.25	78.12	77.63	78.93	78.87	79.11
Fats (ether extract)	0.21	0.44	0.37	0.69	0.35	0.60	0.63	0.47
Ash	1.40	1.88	1.78	2.09	2.34	2.24	2.82	2.08
Proteins	0.79	0.64	0.56	1.82	1.91	1.78	1.29	1.25
Crude fiber	6.74	6.45	6.41	7.33	7.47	7.34	7.34	7.01
Carbohydrate (N. F. E.)	9.67	10.83	11.63	9.95	10.30	9.11	9.05	10.08
Calories per 100 grams	45.00	51.00	53.00	55.00	53.00	50.00	48.00	50.71

SHOULD POTASSIUM SULFATE BE ADDED WITH AMMONIUM SULFATE TO LIPA CLAY LOAM FOR UPLAND RICE?[1]

PABLO C. ENRILE

WITH SEVEN TEXT FIGURES

The restriction on sugar production, which has rather recently been imposed in the Philippines, has resulted in the availability of extensive areas that might be devoted to the growing of upland rice. These areas are mostly of Lipa clay loam, which is generally of rather low or moderate fertility. To make this soil suitable for rice culture, one of the things that might be done is to improve it by judicious applications of commercial fertilizers. Unfortunately, no very definitely beneficial fertilizer or fertilizer mixture is as yet known. For this reason, a series of fertilizer culture tests with upland rice has been started in the Department of Agricultural Botany, of which series the present study is a part.

Review of literature

Rice plants were grown on Lipa clay loam in pots and supplied with varying amounts of ammonium sulfate fertilizer. Interesting results were obtained. Libatique (1931) found that the fertilized plants produced more but shorter roots than the unfertilized ones. He also found that as the amount of ammonium sulfate was increased, there was a corresponding increase in the yield of tops. The yield of grain, however, was increased only up to a certain rate of application of the fertilizer, beyond which further increase was accompanied by a decrease in the yield of grain. Soriano (1934) found that as the amount of the fertilizer was increased, the chlorophyll content of the leaves also increased. He obtained the highest yields of tops of the 30- and 60-day old rice plants from the cultures that received 10.87 grams of ammonium sulfate.

In his desire to determine the cause of the harmful effects upon rice plants of excess ammonium sulfate, Almeda (1937) made further culture studies with rice. By harmful effects, he meant late flowering and consequently late fruiting, the comparatively low yield of grain, and the variable time of ripening of the grains. He studied the effects on dry matter and ash content of rice plants grown in pots by varying the amount of ammonium sulfate. One result of his study was that as the rice plant grew older and as they received more fertilizer, more dry matter was produced. Similarly, he observed that the total ash content of tops increased with the age of the plant and with the amount of ammonium sulfate. A more marked increase in total ash content of tops occurred in the older plants. But the percentage of ash in tops diminished with the age of the plant and with the amount of ammonium sulfate fertilizer used.

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[1] Experiment Station contribution No. 1233. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

Field fertilizer tests with rice conducted in other countries have also shown interesting results. In Texas, Reynolds and Wyche (1929) observed that 100 lb. of ammonium sulfate to the acre (or 112.3 kilograms per hectare) produced rice grains most profitably. In Canton, China, Chan (1929) reported that the application of potash to rice gave no better results than those from the unfertilized cultures. Similar conclusions were obtained in Hawaii by Kelley (1914), who reported that potash and phosphoric acid were practically without effect upon the yield of rice. He also reported that complete fertilizer was no more effective than ammonium sulfate alone, and that the application of both ammonium and potassium sulfates produced an even lower yield than when ammonium sulfate alone was supplied to the plant.

Fontanilla grew in 1934 [2] a lowland variety of rice, Ramai, in field plot cultures in Los Baños. He applied ammonium sulfate and potassium sulfate fertilizers in two different proportions and obtained an average yield of 56.11 ± 2.21 cavans per hectare from the cultures that were supplied with 100 kgm. of ammonium sulfate and 20 kgm. of potassium sulfate. From the second mixture consisting of 200 kgm. of ammonium sulfate and 40 kgm. of potassium sulfate, he obtained a computed yield of 61.19 ± 11.25 cavans per hectare. From the control cultures, only an average yield of 46.93 ± 1.54 cavans was obtained.

Objects of this study

The main object of this study was to determine whether sulfate of potash should be added or not with ammonium sulfate to clay loam to produce good growth and a high yield of upland rice. Incidentally, it was also determined whether Lipa clay loam, one of the most common types of soil in the uplands in the Philippines, lacked sufficient potash or not to produce a high yield of rice.

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[2] FONTANILLA, JUAN B. The effects upon the yield of Ramai rice of the application of different home-mixed fertilizers containing nitrogen and potash. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1934. Unpublished).

Time and place of this study

The culture part of this study was carried out in the experimental yard of the Department of Agricultural Botany. It was begun in June, 1937, and ended in December of the same year.

MATERIALS, METHOD, AND RESULTS

The plant

The rice plants, variety Inintiw, were started from seeds obtained from the Department of Agronomy. These were first soaked in water and afterwards sown four to a kerosene tin. When the plants were one week old, some of them were taken out, and only two uniformly developed seedlings were left in each tin.

The soil

Lipa clay loam was taken from a lot behind the administrative building of the College of Agriculture. It was pulverized, sieved, mixed thoroughly, and about eighteen kilograms were placed in each tin. Samples of the soil were analyzed by the Department of Agricultural Chemistry and found to contain 0.13 per cent N, 0.20 per cent P_2O_5, and 0.37 per cent K_2O.

The cultures and fertilizers used

Two kinds of fertilizers were used: ammonium sulfate and potassium sulfate. According to the dealers from which these were purchased, the sulfate of ammonia contained 20.6 per cent N, and the sulfate of potash, 48-50 per cent K_2O.

Two main series of cultures were tried. The first was conducted from July 12 to October 29, 1937. It consisted of the following sets of cultures:

The ammonium sulfate set. The first set was composed of six cultures supplied with ammonium sulfate in varying amounts. Each culture was run in quadruplicate, and, as shown in table 1, culture I received no fertilizer; culture II, 1.44 grams of ammonium sulfate; culture III, 2.88 grams; culture IV, 5.76 grams; culture V, 8.64

grams; and culture VI, 11.52 grams. The average results[3] are shown in table 1. See also fig. 1.

The potassium sulfate set. The second set consisted of seven cultures supplied with sulfate of potash in varying amounts. Culture I, table 3, had no fertilizer; culture II received 1.44 grams of potassium sulfate; culture III, 2.88 grams; culture IV, 5.76 grams; culture V, 8.64 grams; culture VI, 11.52 grams, and culture VII, 14.40 grams. The average results are shown in table 3. See also fig. 2. This set, with the exception of culture VII, was run only in triplicate.

The ammonium and potassium sulfates set. The third set consisted of twenty-five cultures, supplied with sulfate of potash and sulfate of ammonia combined in different proportions. Each of these cultures was run in quadruplicate, and the average results are given in table 5. See also fig. 3a, 3b, 3c, 3d, and 3e.

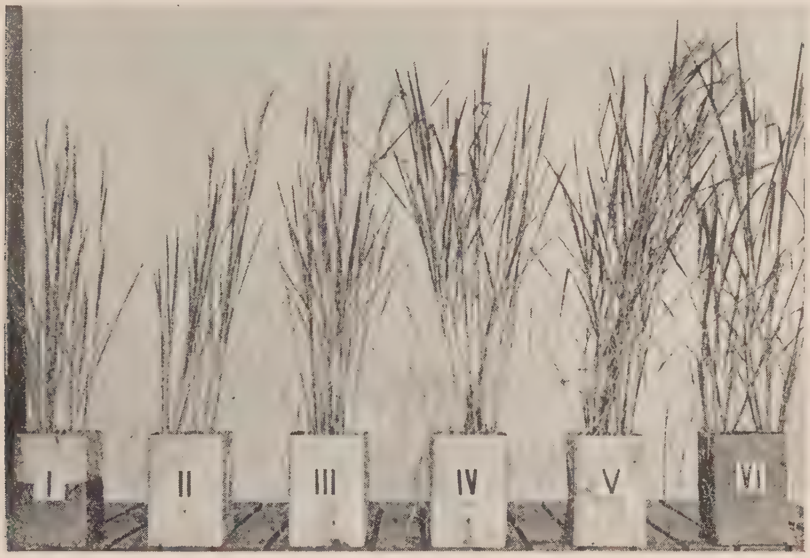

Fig. 1.—Rice plants 70 days old grown in clay loam supplied with varying amounts of ammonium sulfate fertilizer. Cultures I (control) no fertilizer, II, 1.44 grams, III, 2.88 grams, IV, 5.76 grams, V, 8.64 grams, VI, 11.52 grams of ammonium sulfate. (July 12 to October 29, 1937).

Based on the surface area of the pot, the 1.44-gram application was equivalent to ¼ ton per hectare; the 2.88-gram application, to ½ ton per hectare; the 5.76-gram application, to 1 ton per hectare; the

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[3] The mass of the original experimental data for this, as well as subsequent sets, is on file in the Department of Agricultural Botany.

8.64-gram application, to 2 tons per hectare; and the 14.40 grams, the highest rate of application of each of the two commercial fertilizers here tested, to 2½ tons per hectare.

The second series of cultures, similar to those that were tried in the first series, was run from July 30 to November 19, 1937. The fertilizers used and the results obtained are recorded in table 2 for the cultures that were supplied with varying amounts of ammonium sulfate; in table 4, for those supplied with sulfate of potash; and in table 5, for those fertilized with different mixtures of ammonium and potassium sulfate fertilizers.

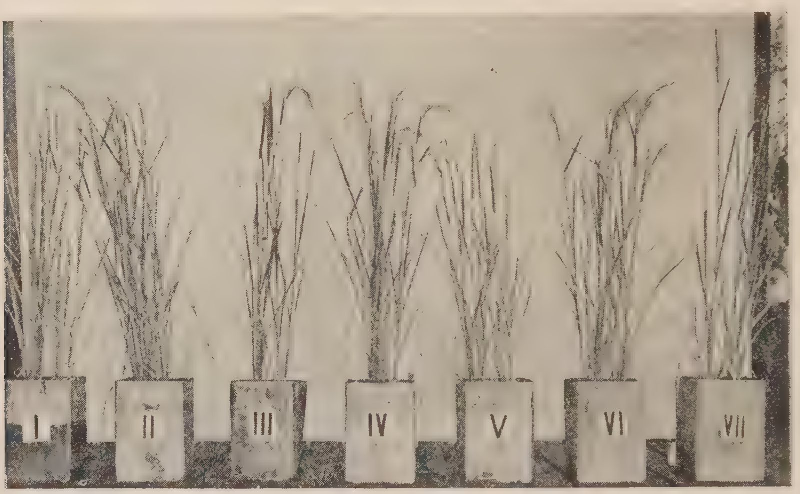

Fig. 2.—Rice plants 70 days old grown in clay loam supplied with varying amounts of potassium sulfate fertilizer. Cultures I (control) no fertilizer, II, 1.44 grams, III, 2.88 grams, IV, 5.76 grams, V, 8.64 grams, VI, 11.52 grams, VII, 14.40 grams of potassium sulfate. (July 12 to October 29, 1937).

Care of cultures

All the cultures were run in the experimental yard of the Department of Agricultural Botany directly exposed to the sun. From time to time, they were weeded and cultivated, and watered whenever necessary.

Criteria of results used

In addition to the photographs that were taken of the representative cultures at the time of harvest, other criteria of results are here employed. These are (*a*) number of tillers, (*b*) height of plants, (*c*) dry weight of grains, (*d*) dry weight of roots, and (*e*) dry weight of tops. All these are used in tables 1 to 5 inclusive, and the experimental data under each of them were obtained as follows:

Number of tillers. The tillers were counted and recorded at the time of harvest. The average data in the tables were obtained by adding together the number of tillers present in the three similar cultures and dividing the sum by three.

Height of plants. The data on height of plants were obtained at the time of harvest. Measurements were made from the base mark placed near the base of the culms to the tip of the tallest leaf in each culture. The data obtained from the three similar cultures were averaged.

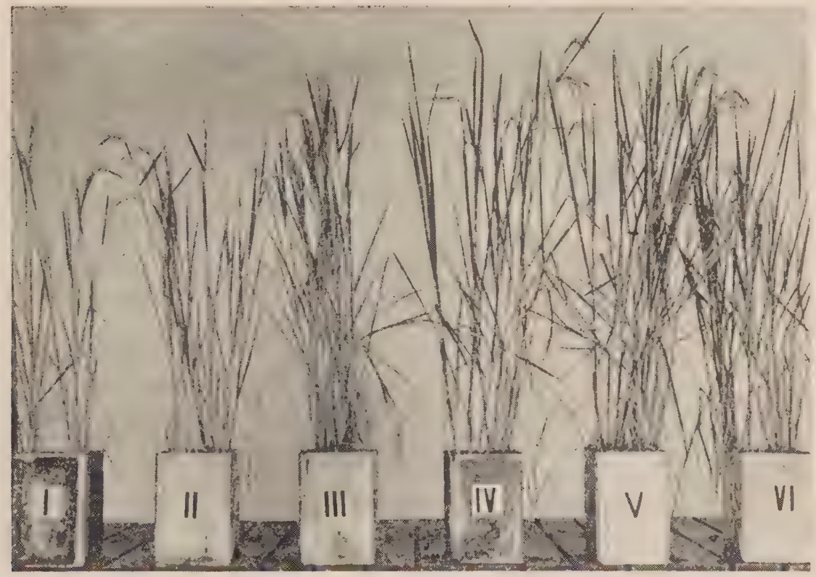

Fig. 3a.—Rice plants 70 days old grown in clay loam supplied with different mixtures of potassium sulfate and ammonium sulfate fertilizers. Cultures I to VI, inclusive, were supplied with 2.88 grams of potassium sulfate but with O, 1.44, 2.88, 5.76, 8.64, and 11.52 grams of ammonium sulfate, respectively. (July 12 to October 29, 1937).

Dry weight of grains. At harvest time, the panicles were gathered from the different cultures and placed in paper bags properly labelled. They were then dried in the sun and further dried in an electric oven to constant weight. The panicles from the different cultures were weighed separately. The data obtained from similar cultures were averaged.

Dry weight of roots. The roots, after the tops had been severed, were removed from the pots, thoroughly washed, and cleaned. Those from each culture were placed in paper bags and labelled properly. They were then dried in the sun and further dried in an electric oven to constant weight. The data obtained from the three similar cultures were averaged.

Dry weight of tops. At the time of harvest, the tops of the plants in each culture were cut close to the ground, wrapped in paper, and labelled. They were first dried in the sun for four days, and then placed in an electric oven to dry to constant weight. Their dry weight was determined and the data obtained from the three similar cultures were averaged.

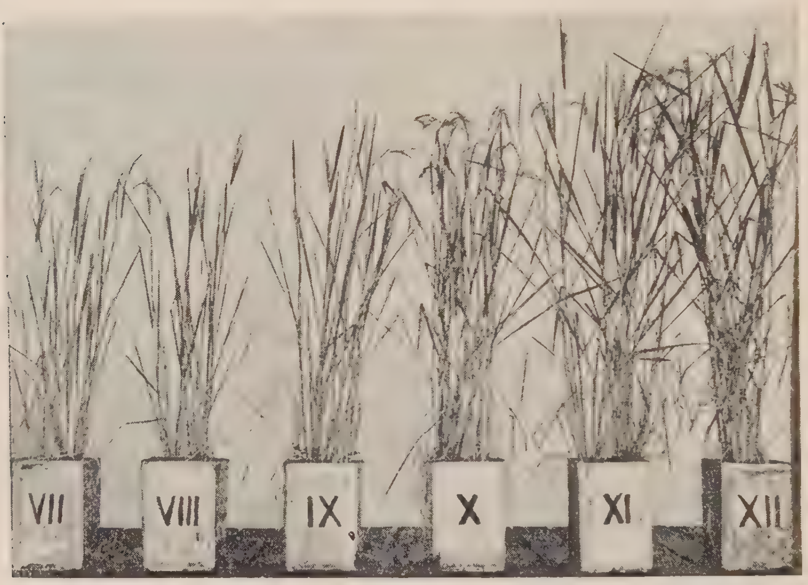

Fig. 3b.—Rice plants 70 days old grown in clay loam supplied with different mixtures of potassium sulfate and ammonium sulfate fertilizers. Cultures VII to XII, inclusive, were supplied with 1.44 grams of potassium sulfate and with O, 1.44, 2.88, 5.76, 8.64, and 11.52 grams of ammonium sulfate, respectively. (July 12 to October 29, 1937).

Weather data

The experimental part of this study was conducted near one of the weather stations of the College; hence, data on weather were obtained from this station (see table A).

TABLE A

MONTH	WIND VELOCITY		RELATIVE HUMIDITY	RAINFALL		TEMPERATURE	
	Day	Night		Inches	Millimeters	Minimum	Maximum
1937	*m/day*	*m/day*	*per cent*			°*C.*	°*C.*
July	72.5	51.3	72.1	8.94	225.8	23.8	32.6
August ...	63.6	37.7	72.4	15.17	386.7	23.5	31.3
September.	50.2	32.8	73.6	11.30	287.5	23.4	31.2
October ..	64.9	39.1	71.6	17.65	448.5	22.8	30.5
November .	74.8	52.6	76.2	12.74	323.7	23.1	29.8

No intention was made to correlate the experimental data that have been obtained with these weather data. Typhoons occurred, but they were not serious enough to damage the cultures.

DISCUSSION OF RESULTS

Before the results obtained from the two series of fertilizer pot cultures are correlated, it should be pointed out that the cultures reported in tables 1, 3, and some in table 5, having been run at the same time, are comparable. Similarly, those that are shown in tables 2, 4, and some in table 5, are also comparable.

Optimum amount of ammonium sulfate fertilizer

After the two highest data under each of the five criteria of results employed in tables 1 and 2 have been arbitrarily selected, and these data indicated by H's, it will be found in table 1 that culture IV received 3 H's, culture V, 4 H's, and culture VI, 2 H's. In table 2, culture V received 5 H's, and culture VI, 4 H's. It appears that in the two tables referred to, culture V received the largest number of H's and may, therefore, be considered as the best in the lot.

Culture V was compared with I, the unfertilized culture, and the data in table B reduced to relative values; the data for the control, or unfertilized culture, was taken as 100.

TABLE B

CULTURE NO.	AMOUNT OF AMMONIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF			DATE OF EXPERIMENT
				Grains	Roots	Tops	
	grams						
I	0	100	100	100	100	100	July 19 to
V	8.64	211	124	235	135	280	Oct. 29, 1937
I	0	100	100	100	100	100	July 30 to
V	8.64	283	108	176	231	286	Nov. 19, 1937

As is to be expected, culture V gave, under all the criteria employed, better results than the corresponding control culture. In fact, in terms of dry weight of the grains and of the straw, culture V was 258 per cent better than the control in the first trial, and 231 per cent better in the second. This culture was fertilized with 8.64 grams of ammonium sulfate, or at the rate of 1½ tons of the fertilizer per hectare, and the results obtained closely confirm the finding of Almeda (1937).

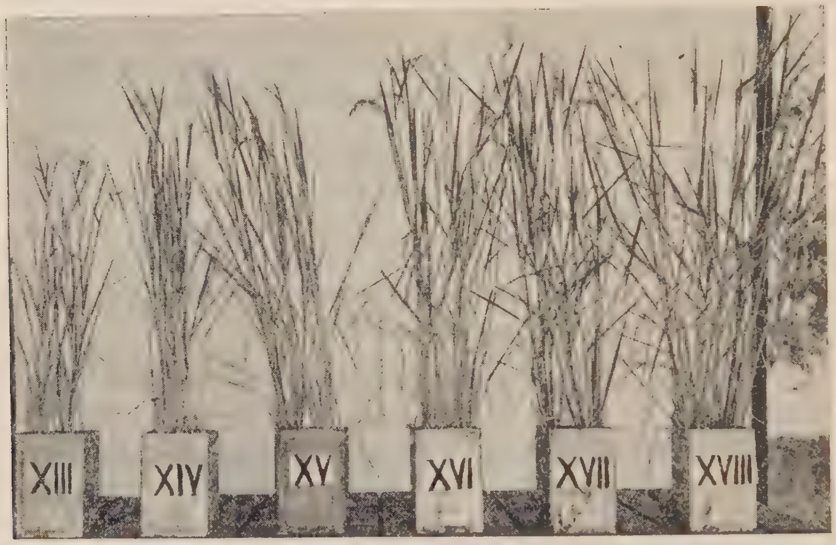

Fig. 3c.—Rice plants 70 days old grown in clay loam supplied with different mixtures of potassium sulfate and ammonium sulfate fertilizers. Cultures XIII to XIX, inclusive, were supplied with 5.76 grams of potassium sulfate but with O, 1.44, 2.88, 5.76, 8.64, and 11.52 grams of ammonium sulfate, respectively. (July 12 to October 29, 1937).

Potash in clay loam when grown to rice

Examination of the data in tables 3 and 4 reveals that, under the criteria of results employed, the distribution among the cultures of the high and low values is so irregular that it is possible to select with ease neither the best nor the poorest cultures in the lot. As shown in table C in which the range of the rest of the application of potassium sulfate is compared with that of the results that were obtained under the different criteria employed, this fertilizer was apparently not effective in promoting growth and development of the rice plant and in increasing the yield of grain. In fact, in many instances, the results obtained from the unfertilized cultures were even better than those from the cultures that had been supplied with the sulfate of potash.

TABLE C

CULTURE NO.	AMOUNT OF POTASSIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT, IN GRAMS		
				Grains	Roots	Tops
	grams		*cm.*			
I	0 (control)	5.2	117.9	20.7	11.7	31.0
II-VII	1.44—14.40	4.2—5.5	109.3—123.8	13.2—22.1	4.9—10.2	20.4—28.9
II-VI	1.44—11.52	4.8—6.3	108.0—122.8	19.2—23.5	5.0— 7.6	24.1—32.0
I	0 (control)	3.1	120.0	15.8	4.4	16.5
I-VII	1.44—14.40	2.8—5.0	101.6—115.4	8.4—16.1	3.6— 5.1	15.0—18.8
I-VI	1.44—11.52	3.1—5.1	91.6—102.1	8.3—14.2	2.8— 5.7	13.8—19.1

The soil here employed whose textural characteristic is clay loam and which may be considered as the most common and consequently the most abundant upland type of agricultural soil in the Philippines, especially in Luzon, either did not lack potash or lacked it in such small amounts that it was not unsuitable for upland rice culture. This finding seems to be in accord with the fact that, according to Willcox (1930), the effect factor of the growth factor potash is so large that it requires only 3.6 quintals per hectare to produce 100 per cent of the maximum yield of any crop. On analysis, the Lipa clay loam that was used in this study was found to contain 0.37 per cent K_2O, potash. Consequently, it appears that the soil had a rather abundant supply of potash.

The addition of potassium sulfate to ammonium sulfate in Lipa clay loam for upland rice

To be able to determine more definitely whether Lipa clay loam lacked potash or not, potassium sulfate fertilizer was added with ammonium sulfate in pot cultures. This was based on the *law of constancy of action of growth factors,* (Willcox, 1930), which states that "all conditions otherwise remaining the same in a given set of conditions affecting the growth of a plant, a definite material alteration in one or more factors will produce a corresponding definite material alteration in the yield of the plant". It was also based on a corollary of this law to the effect that plant growth depends equally on all growth factors, and was more specifically covered by the *law of the joint action of growth factors.* According to this law, "the yield of a crop is the resultant of all the forces and influences exerted on it by the ensemble of growth factors and conditions, both positive and negative, the effect of one factor or condition being additive on the effects of all the others".

Now, potash is a growth factor. Its addition to the soil, alone or in combination with the optimum amount of sulfate of ammonia for rice, should give certain results which would definitely indicate whether the original supply of potash in the soil was enough to produce the best growth and maximum yield of the rice plant.

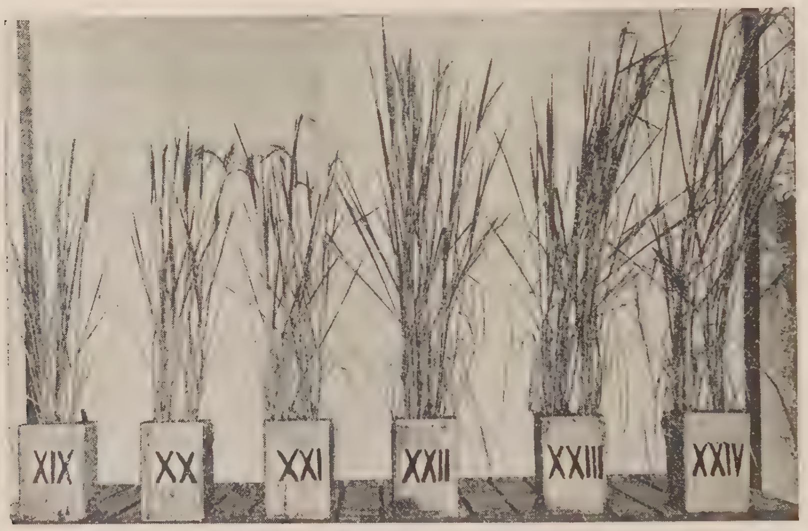

Fig. 3d.—Rice plants 70 days old grown in clay loam supplied with different mixtures of potassium sulfate and ammonium sulfate fertilizers. Cultures XIX to XXIV, inclusive, were supplied with 8.64 grams of potassium sulfate and with O, 1.44, 2.88, 5.76, 8.64, and 11.52 grams of ammonium sulfate, respectively. (July 12 to October 29, 1937).

This comparison can be made after an examination of the data in table 5 for the purpose of selecting a few of the best and the poorest cultures. Three of each should be enough. When the best cultures are indicated by H's and the poorest by L's most of the H's and L's seem to segregate in different parts of the table. Such separate segregation seems to indicate that the best cultures are characterized by certain fertilizer mixtures. Likewise, the poorest have their own characteristic mixtures of the two fertilizers.

Most of the H's are found in cultures which were supplied with relatively large amounts of ammonium sulfate fertilizer, irrespective of the amounts of potassium sulfate that were added to them. On the other hand, most of the L's are found in those cultures characterized usually by the lowest amount of ammonium sulfate, again irrespective of the amounts of sulfate of potash fertilizer present in the culture media. The upper portion of table D bears out these generalizations. In this table, the data under each criterion from all the cultures that received the same amount of ammonium sulfate, irrespective of the amounts of sulfate of potash used, were averaged. The averages thus obtained were converted into relative values, by arbitrarily taking the actual average data under each criterion in culture I-V in table C as 100.

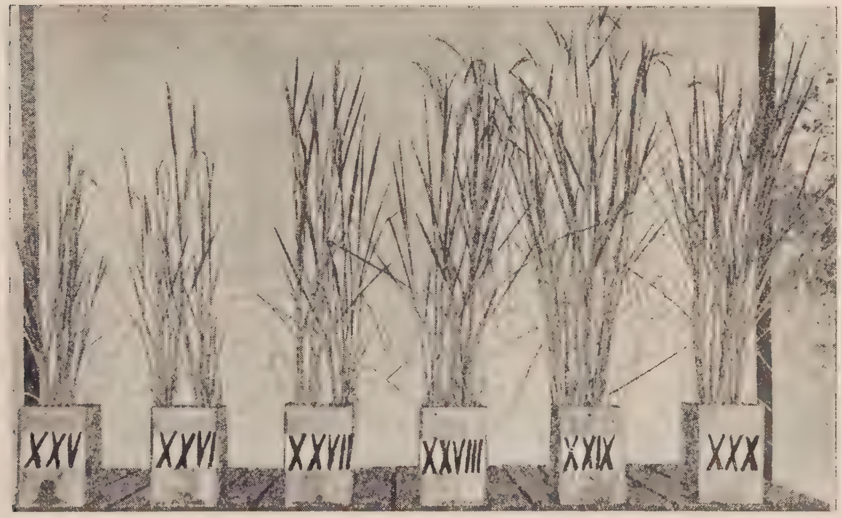

Fig. 3e.—Rice plants 70 days old grown in clay loam with different mixtures of potassium sulfate and ammonium sulfate fertilizers. Cultures XXV to XXX, inclusive, were supplied with 11.52 grams of potassium sulfate and with O, 1.44, 2.88, 5.76, 8.64, and 11.52 grams of ammonium sulfate, respectively. (July 12 to October 29, 1937).

TABLE D

CULTURE NO.	AMOUNT OF FERTILIZER		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF	
	Ammonium sulfate	Potassium sulfate			Grains	Tops
	grams	*grams*				
I-V	1.44	1.44—11.52	100 (6.2)	100 (120.8 cm)	100 (21.9 gm)	100 (37.3 gm)
VI-X	2.88	1.44—11.52	121	111	122	127
XI-XV	5.76	1.44—11.52	124	122	136	169
XVI-XX	8.64	1.44—11.52	147	124	137	190
XXI-XXV	11.52	1.44—11.52	163	123	143	230
	Potassium sulfate	Ammonium sulfate				
I-V	1.44	1.44—11.52	100 (7.8)	100 (139.9 cm)	100 (30.7 gm)	100 (56.1 gm)
VI-X	2.88	1.44—11.52	96	108	82	99
XI-XV	5.76	1.44—11.52	110	104	92	120
XVI-XX	8.64	1.44—11.52	95	97	88	100
XXI-XXV	11.52	1.44—11.52	118	95	101	113

The data in table D show that, having similarly converted the amounts of potassium sulfate in the different culture groups, the differences in relative values under each criterion, if such differences do really exist, were due to no other cause than the differences in the amounts of sulfate of ammonia that have been employed. Such differences in results are seen in table D, for as the amount of ammonium sulfate was increased, the data under each criterion increased, too, although, as expected in accordance with the *law of diminishing increments of yields,* not in direct proportion.

On the other hand, if the data in the lower portion of table D is considered, it will be found that the magnitudes of the relative values are arranged in neither an ascending nor descending order. In fact, the relative values of the data in this table appear not to have been influenced by varying the amounts of sulfate of potash in the culture media. These observations also hold true, as shown in table E of the cultures in the second series.

It may be concluded that, as far as the growth and yield of this upland rice in Lipa clay loam in pots, potassium sulfate in amounts tried in this study had no material effects in making them productive or not.

TABLE E

CULTURE NO.	AMOUNT OF FERTILIZER		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF	
	Ammonium sulfate	Potassium sulfate			Grains	Tops
	grams	*grams*				
I-V	1.44	1.44—11.52	100 (5.8)	100 (108.6 cm)	100 (16.8 gm)	100 (25.9 gm)
VI-X	2.88	1.44—11.52	109	109	112	114
XI-XV	5.76	1.44—11.52	137	126	114	201
XVI-XX	8.64	1.44—11.52	141	131	113	232
XXI-XXV	11.52	1.44—11.52	169	136	115	266
	Potassium sulfate	Ammonium sulfate				
I-V	1.44	1.44—11.52	100 (8.2)	100 (125.3 cm)	100 (26.5 gm)	100 (52.6 gm)
VI-X	2.88	1.44—11.52	86	107	88	88
XI-XV	5.76	1.44—11.52	91	102	83	93
XVI-XX	8.64	1.44—11.52	86	110	72	86
XXI-XXV	11.52	1.44—11.52	86	95	77	90

Further study of the data in table E may reveal specifically the best cultures and consequently the fertilizer mixtures that each of them received. For this purpose table F is presented.

TABLE F

CULTURE NO.[a]	AMOUNT OF FERTILIZER		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF	
	Ammonium sulfate	Potassium sulfate			Grains	Tops
	grams	*grams*				
I (I)	0	0	100 (5.2)	100 (117.9 cm)	100 (20.7 gm)	100 (31.0 gm)
II (V)	8.64	0	212	127	231	280
III (XX)	8.64	11.52	226	129	222	301
IV (XXIII)	11.52	5.76	242	134	157	306
V (XXV)	11.52	11.52	230	118	197	367
I (I)	0	0	100 (3.1)	100 (120.0 cm)	100 (15.8 gm)	100 (16.5 gm)
II (V)	8.64	0	284	108	176	317
III (XIII)	5.76	5.76	313	122	182	360
IV (XX)	8.64	11.52	290	111	174	440
V (XXIV)	11.52	8.64	290	114	152	469
VI (XXV)	11.52	11.52	300	113	139	417

[a] The culture numbers in parentheses are the original—(I) and (V) from tables 1 and 2; the rest from table 5.

Cultures I and II in the upper portion were taken from table 1, while cultures I and II in the lower portion came from table 2. The rest of the cultures came from table 5, being those in both series receiving a number of H's and consequently the best in the two series or lots. The actual values under each criterion of results were, in terms of the control culture (culture I), reduced to relative values.

Inspection of the data in table F reveals that only two cultures (XX and XXV) appear both in the upper portion (first series) and in the lower portion (second series). In a way, these two cultures might be considered as the best in the lots were it not for the fact that in a number of data the other cultures excel them. To be sure, there is not any culture either in the first or second series that possesses, under the criteria employed, experimental data consistently higher than the corresponding data in the other cultures. It would, therefore, appear that for the present the selection of the best mixture of potassium sulfate and ammonium sulfate for this variety of upland rice might be postponed, at least, until the cultures in table F shall have been tried again and consistent results obtained.

Further inspection of the data in table F, however, seems to show that culture II, which received only 8.64 grams of ammonium sulfate per pot (or at the rate of 1½ tons per hectare), gave data that were just a little lower than the corresponding data for the selected cultures that received both fertilizers. In several instances, the yields for culture II were even higher than the corresponding yields from the other cultures. For these reasons, it may be concluded that under the conditions of this study it may not be advisable or profitable to add potassium sulfate with sulfate of ammonia to Lipa clay loam for upland rice of variety Inintiw. Addition of ammonium sulfate fertilizer alone to the soil at the rate of 1½ tons per hectare would be sufficient to produce an excellent growth and high yield of the rice plant.

SUMMARY OF CONCLUSIONS

1. In terms of dry weight of grains and of straw, culture V was 258 per cent better than the control (unfertilized) culture in the first trial, and 231 per cent better than the control in the second. This culture was fertilized with 8.64 grams of ammonium sulfate, or at the rate of 1½ tons per hectare, and the results obtained closely confirm the finding of Almeda (1937).

2. It appears that the Lipa clay loam employed either did not lack potash or lacked it in only such a very small amount as not to make it unsuitable for upland rice culture.

3. Under the conditions of this study, it may not be advisable or profitable to add potassium sulfate with sulfate of ammonia to Lipa clay loam for upland rice. Addition of ammonium sulfate fertilizer alone to the soil at the rate of 1½ tons per hectare would seem to be sufficient to produce an excellent growth and high yield of the rice plant.

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TABLE 1

Average harvest data of an upland rice in clay loam in pots with ammonium sulfate fertilizer

(EXPERIMENT FROM JULY 12 TO OCTOBER 29, 1937)

CULTURE NO.	AMMONIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF			EXTERNAL APPEARANCE OF PLANTS
				Grains	Roots	Tops	
	grams		*cm.*	*grams*	*grams*	*grams*	
I	0	5.2	117.9	20.68	11.67	30.99	Leaves light green in color
II	1.44	7.5	115.1	21.29	14.55	35.30	Leaves green
III	2.88	8.7	129.3	29.66	14.23	52.72	Same as in Culture II
IV	5.76	10.8H	134.5	42.68H	17.31H	68.81	Leaves slightly more dark green in color than those in Culture III
V	8.64	11.0H	145.8H	48.74H	15.84H	86.97H	Leaves dark green in color
VI	11.52	8.7	149.8H	41.79	8.58	75.97H	Same as in Culture V

TABLE 2

Average harvest data of an upland rice grown in clay loam in pots with ammonium sulfate fertilizer

(EXPERIMENT FROM JULY 30 TO NOVEMBER 19, 1937)

CULTURE NO.	AMMONIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF			EXTERNAL APPEARANCE OF PLANTS
				Grains	Roots	Tops	
	grams		*cm.*	*grams*	*grams*	*grams*	
I	0	3.1	120.0	15.77	4.37	16.46	Leaves light green in color
II	1.44	6.3	106.6	19.04	8.65H	27.86	Leaves green
III	2.88	6.3	116.5	15.81	8.56	29.01	Same as in Culture II
IV	5.76	6.3	122.3	21.23	7.75	42.95	Leaves slightly more dark green in color than those in Culture III
V	8.64	8.8H	130.0H	27.83H	10.17H	47.31H	Leaves dark green in color
VI	11.52	9.2H	138.3H	25.66H	7.36	47.42H	Same as in Culture V

TABLE 3

Harvest data from cultures of an upland rice grown in clay loam in pots with potassium sulfate fertilizer

(EXPERIMENT FROM JULY 12 TO OCTOBER 29, 1937)

CULTURE NO.	AMMONIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF			REMARK
				Grains	Roots	Tops	
	grams		*cm.*	*grams*	*grams*	*grams*	
I	0	5.2	117.9	20.7	11.7	31.0	Average of quadruplicate cultures
II	1.44	6.5	117.0	22.1	9.4	28.9	
III	2.88	4.2	119.9	15.4	9.6	23.1	
IV	5.76	4.7	118.7	21.2	5.6	26.2	
V	8.64	5.0	109.3	13.2	4.9	20.4	
VI	11.52	4.3	113.6	19.4	6.0	27.2	
VII	14.40	4.6	183.8	16.7	10.2	26.2	
I	0	5.2	117.9	20.7	11.7	31.0	Average of triplicate cultures
II	1.44	4.8	172.5	19.9	6.5	24.1	
III	2.88	6.3	108.0	19.2	7.6	28.0	
IV	5.76	5.3	116.6	21.3	8.1	31.2	
V	8.64	5.8	121.8	23.5	5.0	32.0	
VI	11.52	5.6	122.8	21.5	7.3	32.0	

TABLE 4

Harvest data from cultures of an upland rice grown in clay loam in pots with potassium sulfate fertilizer

(EXPERIMENT FROM JULY 30 TO NOVEMBER 19, 1937)

CULTURE NO.	POTASSIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF			REMARK
				Grains	Roots	Tops	
	grams		*cm.*	*grams*	*grams*	*grams*	
I	0.00	3.1	120.0	15.8	4.4	16.5	Average of quadruplicate cultures
II	1.44	2.8	115.4	12.1	5.1	18.8	
III	2.88	3.4	111.0	14.8	5.1	17.2	
IV	5.76	4.0	101.6	8.4	4.2	15.0	
V	8.64	3.8	110.8	16.1	4.8	17.3	
VI	11.52	4.5	104.0	13.1	3.6	18.2	
VII	14.40	5.0	104.7	14.8	5.0	17.1	
I	0.00	3.1	120.0	13.8	4.4	16.5	Average of triplicate cultures
II	1.44	3.7	92.2	9.1	2.8	13.8	
III	2.88	3.8	98.8	11.2	3.8	17.3	
IV	5.76	5.1	102.1	14.2	4.9	19.1	
V	8.64	4.5	91.6	8.3	5.7	15.7	
VI	11.52	3.1	101.6	13.8	4.7	16.2	

TABLE 5

Average harvest data of an upland rice in clay loam in pots with ammonium and potassium sulfate fertilizers

CULTURE NO.	FERTILIZER APPLIED		FIRST SERIES (JULY 12 TO OCTOBER 29, 1937)					TOTAL NUMBER OF H'S OR L'S	SECOND SERIES (JULY 30 TO NOVEMBER 19, 1937)					TOTAL NUMBER OF H'S OR L'S
	Ammonium sulfate	Potassium sulfate	Number of tillers	Height of plants	Dry weight of				Number of tillers	Height of plants	Dry weight of			
					Grain	Roots	Tops				Grain	Roots	Tops	
	grams	*grams*		*cm.*	*grams*	*grams*	*grams*			*cm.*	*grams*	*grams*	*grams*	
I	1.44	1.44	6.8	123.8L	25.3	11.4	36.8	1L	7.5	113.3	18.2	9.3	31.6	
II	1.44	2.88	6.0L	116.6L	18.6L	9.5	39.7	4L's	5.5L	113.3	18.6	7.1	26.7	1L
III	1.44	5.76	6.3	129.0	21.0	12.6H	48.7	1H	5.6	104.4L	13.8L	7.4	22.4L	3L's
IV	1.44	8.64	6.1L	115.3L	24.7	6.0L	34.8L	4L's	6.0	106.1	18.6	6.1	25.4L	1L
V	1.44	11.52	5.8L	119.6	19.8L	10.5	35.5L	3L's	4.6L	103.3L	14.7L	6.8	23.6L	4L's
VI	2.88	1.44	7.8	137.5	31.3	12.6	45.7		6.3	121.6	19.5	10.0	39.9	
VII	2.88	2.88	7.8	133.1	25.5	9.8	48.7		6.5	121.6	19.5	9.8	35.6	
VIII	2.88	5.76	6.6	137.3	25.3	7.8	54.8		6.1	112.8	23.3	6.0L	37.6	1L
IX	2.88	8.64	7.7	132.3	25.8	10.2	47.1		5.9	106.5	18.0	6.1	32.1	
X	2.88	11.52	7.8	125.8	25.7	9.6	42.3		5.3L	105.8L	17.1	4.0L	26.6	3L's
XI	5.76	1.44	8.5	151.6	54.7	9.3	56.3		8.6	123.8	28.4H	8.1	60.6	1H
XII	5.76	2.88	6.6	147.1	28.5	10.4	61.4		6.6	133.8	24.5	7.3	46.7	
XIII	5.76	5.76	9.3	147.6	22.5	5.3L	63.9		9.7H	146.5H	28.7H	10.0	59.3	3H's
XIV	5.76	8.64	6.5	141.5	29.4	7.9	70.3		7.0	118.0	15.4L	7.2	47.2	1L
XV	5.76	11.52	8.5	141.5	30.4	6.9L	64.3		7.5	120.8	21.3	7.8	47.4	
XVI	8.64	1.44	9.0	147.8	37.5H	7.8	69.7	1H	2.5	133.6	23.1	8.0	62.3	
XVII	8.64	2.88	8.1	142.5	24.9	7.2	63.3		7.8	141.8	24.0	5.9	54.1	
XVIII	8.64	5.76	8.5	153.0H	16.1L	8.2	71.4	1H	8.1	137.3	17.4	9.6	70.8	
XIX	8.64	8.64	8.3	147.6	21.5	9.3	59.1		7.5	125.0	19.4	5.5L	44.3	1L
XX	8.64	11.52	11.8H	151.6	46.1H	14.0H	92.6H	4H's	9.0	133.3	27.5H	12.1H	72.6H	3H's
XXI	11.52	1.44	9.0	139.1	24.9	8.8	71.8		10.0H	134.5	23.7	8.4	68.5	1H
XXII	11.52	2.88	8.8	156.1H	28.7	7.7	75.8	1H	9.1	144.7H	25.9	4.2L	71.9H	2H's, 1L
XXIII	11.52	5.76	12.3H	136.3H	32.4	9.2	98.3H	3H's	8.0	148.0H	25.9	6.1	36.6	1H
XXIV	11.52	8.64	8.3	141.1	35.3H	9.3	69.3	1H	9.0	136.1	24.0	11.6H	77.1H	2H's
XXV	11.52	11.52	12.0H	137.8	34.0	19.6H	114.0H	3H's	9.3H	133.5	22.1	11.6H	63.8	2H's

ABSTRACT

A further study of the values of various mash mixtures for egg production. PAULINO A. GUERRERO. (*Experiment Station contribution No. 1234.*)—The objects of this study were: (1) to compare the efficiency of the different rations; (2) to compare the efficiency of "grain and mash" and "all mash" rations; and (3) to compare the efficiency of an "all mash" ration with a similar one in which two parts of the corn is replaced with two parts of molasses.

The author used 125 Los Baños Cantonese pullets which were just beginning to lay eggs. The pullets were divided into five lots of 25 birds each with two roosters added to each lot. The five lots were given equal care and treatment in management.

The proportions of the ration given to each lot were:

1. Grain, corn: Lots 1, 2, and 3 were given 10 parts whole corn; lot 4, 10 parts of corn ground into meal and mixed with mash; lot 5, 8 parts corn ground into meal and mixed with mash containing two parts molasses.
2. Rice bran: Lots 1, 4, and 5 were given 4 parts; lot 2, 5 parts; and lot 3, 6 parts.
3. Copra meal: Lots 1, 4, and 5, 3 parts; lot 2, 2 parts; and lot 3, 1 part.
4. Corn meal: All lots were given 1 part.
5. Shrimp meal: All lots were given 2 parts.

The grain was fed regularly, morning and afternoon. The pullets in lots 1, 2, and 3 were hand-fed with grain and self-fed with mash. No grain was given to lots 4 and 5. In all lots, the mash was fed dry, morning and afternoon, in open mash hoppers. Wet mash was given only at noon.

The results obtained were:

1. The average for the year of feed consumption per bird in each lot was: lot 4, 26.5 kgm.; lot 1, 25.7 kgm.; lot 2, 25.5 kgm.; lot 3, 24.2 kgm.; and lot 5, 23.6 kgm.
2. The molasses ration, lot 5, proved to be the least efficient of all the rations compared.

3. It was found that the highest percentage increase in weight of the birds was in lot 1; the second highest was in lot 5. Lots 2, 3, and 4 were about the same.

4. The highest average percentage of egg production during the year was in lot 1 (check), 24.28 per cent; lot 4 had 21.61 per cent; lot 2, 20.62 per cent; lot 3, 19.38 per cent; and lot 5, 17.72 per cent.

5. At three centavos an egg, the current price, the value of the eggs produced in each lot was ₱57.27 for lot 1; ₱55.08, lot 4; ₱52.83, lot 2; ₱40.80, lot 3; and ₱38.49, lot 5.

6. With the cost of feeds to produce one dozen eggs as a basis, the ration given to lot 5 was the least efficient, and the ration given to lot 1, the most efficient.

7. According to the results obtained in lot 5, an "all mash" ration in which 2 parts of the corn meal is replaced with two parts molasses is not good for layers.

—*Abstract by Segundino O. Barraquero*

COLLEGE AND ALUMNI NOTES

First-semester classes began on June 2, with a total enrollment of 507 students, of whom 131 were new and 39 cross-registrants from the School of Forestry. At the opening exercises in the College auditorium, Dr. Miguel Manresa spoke on behalf of the faculty and Dr. Valente Villegas gave a brief account of his travels in Malaya, French Indo-China, and Siam; Mr. Isidro Macaspac, of the student body, tipped the new students on the "ways" of the professors. Dean Gonzalez gave the address of welcome.

Elected officers of the student body for the first semester, 1938-39: Mr. Amando Libunao, president; Mr. Victor U. Luis, vice-president; Mr. Pedro R. de Peralta, secretary; Mr. Ramon Samaniego, treasurer; Messrs. Dioscoro Umali and Francisco Soriano, representatives to the U. P. Student Council; and Mr. Isidro C. Macaspac, representative to the board of management of *The Philippine Collegian.*

The delegates of the College to the Baguio Conference last summer were Dean B. M. Gonzalez, Drs. F. M. Fronda, F. O. Santos, N. B. Mendiola, A. L. Teodoro, L. G. Gonzalez, A. I. de Leon, M. Manresa, M. Mondoñedo, J. M. Capinpin, G. Guanzon, Professors Josefa D. Diaz, José E. Velmonte, Alejandro B. Catambay, Teodosio Buenaventura, and Messrs. Andres Aglibut, Gerardo Capati, and Getulio B. Viado. A dance was given by the Los Baños delegates for the faculty from the Manila, Cebu, and Vigan units of the University on May 20 at the U. P. Mess Hall.

Dr. Valente Villegas, assistant head of the Department of Animal Husbandry, returned to the Campus on May 12 from his trip to Malaya, French Indo-China, and Siam.

Dr. L. B. Uichanco, head of the Department of Entomology, made a trip to Mindanao from April 16 to May 11 to continue his studies on the migratory locust. He visited the interior of Cotabato and the provinces of Oriental Misamis, Lanao, Zamboanga, Davao, and Sulu.

Dr. Pedro A. David, assistant professor of agronomy, spent a month, from April 30 to June 2, studying plantation conditions in Mindanao. Among the places he visited were San Ramon Penal Colony, Patalon Estate and Goodyear Rubber Plantation Company, in Zamboanga; American Rubber Plantation, in Basilan; and the abacá and coconut plantations of Ohta Development Company, Furukawa Plantations, and Kumassie Plantation Company, in Davao. He found that ramie, or China grass, was extensively cultivated in the Ohta and Furukawa plantations and the fiber exported to Japan.

The College made a shipment of twenty-four Los Baños Cantonese pullets and four Los Baños Cantonese cockerels to Bishop Hall, of Hongkong, China, on March 21. The fowls are to be used in the Bishop's mission school.

Dr. N. B. Mendiola, head of the Department of Agronomy, has been designated Philippine correspondent for the journal *La Technique Agricole Internationale,* according to a letter received from Prof. Franco Angelini, secretary general of the International Federation of Technical Agriculturists.

Mr. Tyuhei Mori, who has been sent by the Formosan Government General to study industrial conditions in the Philippines, was a Campus visitor on June 3. Drs. Baltazar and David, of the Department of Agronomy, accompanied him to the laboratories and farms of the College.

Dr. Miguel Manresa, of the Department of Animal Husbandry, was the commencement speaker at Pampanga Agricultural High School, Magalang, Pampanga, on March 30.

Two delegations of provincial and municipal officials were on the Campus last summer—the Tarlac group, on April 6, and the Nueva Ecija delegation, on April 27.

Mr. Dominador Clemente, '33, of Nueva Vizcaya High School, and Mr. Salvador Pacion, '30, of Cagayan High School, were recent Campus visitors. They accompanied their principals who were mainly interested in the vocational courses of the College.

A severe epizootic almost wiped out the chicken flocks in the communities around the Campus and in neighboring municipalities in May, 1938. However, the College flocks have been spared, owing doubtless in part to luck and also to the resistance of the College poultry and the sanitary measures rigidly observed in the poultry premises.

The Reserve Officers' Service School, conducted on the Campus by the Philippine Army primarily for teachers, from April 4 to May 28, held its closing exercises at Baker Memorial Hall, with Assemblyman Claudio Sandoval as principal speaker. Among those who graduated from the school were alumni and former students of this College: Elias M. Caray, '21, principal of Batangas High School; Nicomedes C. Flores, '27, principal of Romblon Rural High School; Luis A. Aldea, '33, provincial agricultural supervisor of Capiz; Lorenzo Goco, '21, and Arcadio G. Matela, '29, industrial supervisors; Julian A. Belo, '28, Alberto C. Elefaño, '33, José Luna, '37, Teodoro P. Malasig, '38, Pascual Matulac, '30, Osmundo Mondoñedo, '34, Pedro Y. Yatar, '34, Marcial V. Enriquez, '37, Rufino Pabico, Rene G. Prado, and Severino Salvado, '30.

On the honor roll of the College at the close of the second semester, 1937-38, were Messrs. Lorenzo P. Zialcita, Senior; Jose R. Velasco, Sophomore; and Ian Khambanonda, Junior.

Recent campus visitors were:

Dr. Frederick K. Morris, professor of structural and engineering geology, Massachusetts Institute of Technology, and Mrs. Morris.

Dr. Walter Carter, entomologist, Hawaiian Pineapple Canners' Association.

Upon the request of the estate management, Dr. Francisco M. Fronda, associate professor of poultry husbandry, accompanied by Mr. Amando M. Dalisay, assistant in poultry husbandry, went to Calamba Sugar Estate on April 26 and spoke to the *aparceros* about the importance of raising standard-bred chickens as a side line. The work was in line with the estate's program of creating sources of supplementary income for its tenants.

Mr. Eligio Ureta, '21, principal of Mampising Agricultural School in Davao, spent a short vacation at Los Baños last summer and saw his first child graduate from the Los Baños Elementary School.

One of the recent alumni visitors to the campus was Mr. Genaro Layug, '32, who came to visit the College for the first time since his graduation. He is an assistant chemist in Central La Carlota, Occidental Negros.

THE USE OF COPRA MEAL IN DUCK RATIONS FOR EGG PRODUCTION [1]

F. M. FRONDA AND ENGRACIO BASIO
Of the Department of Animal Husbandry

Crucillo (1926) used copra meal in various amounts as the sole protein supplement in rations for laying hens and reported that this concentrate may be used as a supplement in rations for egg production provided that it forms not more than 30 per cent of the ration. If copra meal could be used in laying rations for ducks, it would be a distinct advantage to the local duck raisers as it would mean a more economical production of eggs. Local duck raisers, however, seem to be unanimous in not favoring the use of copra meal in rations for laying ducks. Inquiries made among a number of duck growers in Laguna and Rizal revealed that among those interviewed not a single individual included copra meal in the laying ration. Why such a condition should exist in spite of the fact that copra meal is readily available and cheap and that it contains all the food elements in satisfactory amounts and its content of proteins is fairly high (Santos, 1920; Caray, 1921), there must be some important reason.

The object of this study was to determine the effect of the addition of copra meal in laying rations on the production of eggs among ducks. The experiment was started on August 16, 1936, and it was closed on November 16, 1936. A period of 93 days was, therefore, covered by these feeding trials.

In this study, one hundred and twenty laying ducks and twelve drakes were used. These ducks, most of which were in their second laying year and some in their third, belonged to a private owner and were loaned to the Department for use in this experiment. After three months of feeding, the results obtained showed so conclusively the effects of copra meal on the egg production of the ducks that it was thought best to discontinue the experiment for fear that permanent unfavorable effects on the ducks might result.

There were four lots in this experiment, each lot containing thirty ducks and three drakes. The ducks received the ration re-

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[1] Experiment Station contribution No. 1238.

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ported by Fronda and Mencias (1937) to be the best for egg production in ducks for about a month before they were given the test rations. The rations that were tested consisted of the following ingredients, all parts being by weight:

FEEDS USED	LOT I	LOT II	LOT III	LOT IV
Fish meal	30.0	20.0	10.0	...
Copra meal	...	10.0	20.0	30.0
Corn meal	17.5	17.5	17.5	17.5
Rice bran	52.5	52.5	52.5	52.5
Total	100.0	100.0	100.0	100.0

To every 100 kilograms of each of the mash mixtures studied, one kilogram of common table salt and three kilograms of ground fresh water shells were added. Chopped green grass was given to each lot morning and afternoon. The feed was given wet four times a day; twice in the morning, at six and at ten o'clock; and twice in the afternoon, at two and at four o'clock. The ducks were given in each feeding time as much feed as they were able to consume in about twenty minutes. They had access to plenty of fresh drinking water.

RESULTS AND DISCUSSION

The results showed that lot I (30 fish meal—0 copra meal) produced a total of 806 eggs during the period of 93 days; lot II (20 fish meal—10 copra meal), 611 eggs; lot III (10 fish meal—20 copra meal), 488 eggs; and lot IV (0 fish meal—30 copra meal), only 104 eggs. Expressed in terms of percentage egg production, the production of lot I was 28.9 per cent; of lot II, 21.9 per cent; of lot III, 17.5 per cent; and of lot IV, only 3.8 per cent. It can be seen from these figures that where copra meal formed the sole source of protein supplement in the ration, the ducks hardly produced eggs, and as the amount of copra meal in the ration increased, the egg production decreased.

The feed records showed that lot I (30 fish meal—0 copra meal) actually consumed a total of 562.5 kilograms of feed; lot II (20 fish meal—10 copra meal), 582.5 kilograms; lot III (10 fish meal—20 copra meal), 579.7 kilograms; and lot IV (0 fish meal—30 copra meal), 479.0 kilograms. There was, therefore, no significant difference between the feed consumption of lots I, II, and III, but it is apparent that the ration containing 30 per cent copra meal was not as palatable as the other rations tested. In spite of the fact that lot IV (0 fish meal—30 copra meal) consumed the least feed, this lot produced the most expensive eggs for it made a total of only 104 eggs during the period of the test. Although the check lot, lot I (30 fish meal—0 copra meal), produced the most economical eggs, yet this result could not compare with that reported by Fronda and Mencias (1937) for the ducks used in their test were much younger and, hence, were more productive than those used in the present study.

One of the reasons given by some local duck raisers why ducks should not be given copra meal in the ration is that copra meal is too oily and, for this reason, it stimulates the production of fat instead of eggs. It is to be regretted that this test had not been carried on sufficiently long to corroborate this belief. It may be mentioned, however, that all the ducks in all the lots under observation appeared to be equally active and in excellent condition. During the test, one duck died in each of lots I (30 fish meal—0 copra meal), III (10 fish meal—20 copra meal), and IV (0 fish meal—30 copra meal), and none in lot II (20 fish meal—10 copra meal).

SUMMARY AND CONCLUSIONS

A study of the effects of the addition of copra meal in laying rations on the egg production of ducks was made and the results obtained were reported in this paper. These results may be summarized as follows:

1. The addition of copra meal in laying rations for ducks did not produce any advantage in egg production.
2. As the amount of copra meal in the ration increased, the egg production was observed to decrease.
3. Where copra meal formed the sole source of protein supplement in the ration, the ducks hardly produced eggs.
4. It was apparent that the ration containing 30 per cent copra meal was not as palatable as the other rations tested.
5. All the ducks in all the lots under observation appeared to be equally active and in good condition.

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COST OF PRODUCTION AND MARKETING OF NATIVE WOVEN CLOTHS IN BANGAR, LA UNION [1]

SOCORRO V. OLALDE

WITH ONE TEXT FIGURE

The weaving of cloth is the principal and perhaps the oldest household industry in some regions of the Philippines. Although cloth weaving was widely known in the Philippines during the Spanish regime, its popularity and commercial value were widely spread only among the Ilocano provinces. Up to about a decade ago, the town of Bangar,[2] La Union, produced blankets, towels, table cloths,

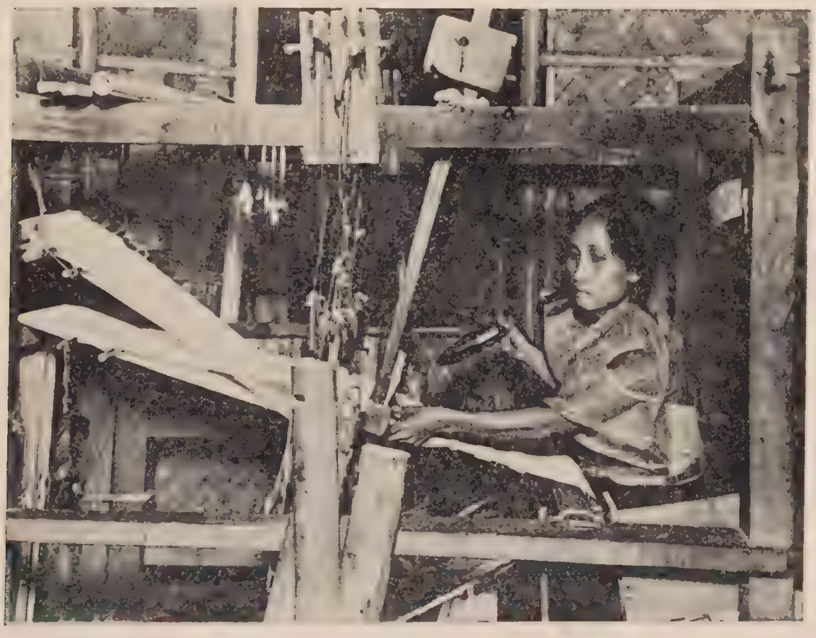

Fig. 1.—Cloth weaving

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[1] Experiment Station contribution No. 1239. Prepared in the Department of Agricultural Economics under the direction of Dr. Pablo N. Mabbun.

[2] Bangar is one of the largest towns of the province of La Union, having a population in 1918 of 10,923.

and napkins. Eala (1926) observed, however, that the towels of Bangar are very much inferior in quality and durability to those produced in Paoay, Ilocos Norte. Consequently, towels from Paoay have displaced those of Bangar in the market. This has forced Bangar to specialize in the production of blankets in commercial quantities.

With the incentive and encouragement now given by the Commonwealth Government to native industries, the blankets of Bangar will likely become more and more important in the domestic market. In view of this possibility, the methods of marketing the product are of interest. A knowledge of the factors affecting the cost of production and distribution of these native woven cloths would serve as a basis for recommending improvements. The extent to which this native industry is dependent upon local cotton farming would be of interest also, particularly to students of agriculture.

Review of literature

Eala (1926) studied the production and marketing of native woven cloths in Paoay, Ilocos Norte. He found that from 15 to 20 per cent of the total production of that town is sold directly by the weavers to the consumers, and the rest reaches the consumers through the middlemen. He recommended that great improvement in the marketing of the products could be accomplished through co-operative marketing associations among the weavers. He found also that the cloth weaving industry of Paoay is entirely dependent upon imported yarns because the weavers found it far cheaper to buy the imported threads than to raise the cotton fiber to supply the industry.

Rivera (1931) states that the principal consumers of "Abel Iloco"[3] are the Ilocanos themselves who have used this kind of cloth from time immemorial. The provincial capitals, such as Vigan, Laoag, and San Fernando, La Union, are the principal markets for the articles. In these towns there are regular dealers engaged in buying and selling native cloths. From there and from the weaving centers, the woven fabrics are taken from town to town and from province to province.

Objects of the present work

The objects of the present work were: (*a*) to determine the cost of production of native woven cloths in Bangar, La Union, (*b*) to study the methods and determine the cost of marketing these locally woven cloths, and (*c*) to determine to what extent the cloth weaving industry in Bangar is dependent upon local cotton farming.

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[3] "Abel Iloco" is a term which means cloth woven by the Ilocanos in the Ilocos provinces of La Union, Ilocos Sur, Ilocos Norte, and Abra.

Time and place of present work

The survey was conducted from December 23, 1935, to January 8, 1936, and from April 2 to June 4, 1936, in the town of Bangar, province of La Union.

MATERIALS AND METHODS

The weavers were approached at random with prepared questionnaires and data were recorded according to their answers. A total of 160 weavers in Paratong Norte and Paratong Sur, the two most important cloth-weaving barrios of Bangar, La Union, were interviewed.

SURVEY AND RESULTS

Cost of production

Raw materials. Rivera (1931) states that for many years in the past the weaving occupation in the north was supplied with raw cotton materials which had been locally produced. Owing to the large importation of cheap yarns from China, the United States, Great Britain, and Japan, however, cotton growing in that region is now at a low ebb, according to him.

The imported yarns used for weaving blankets in Bangar are retailed in a few Chinese and Filipino stores, as well as by Filipino merchants from the neighboring provinces. The materials used in weaving native cloths in Bangar are unbleached yarns No. 10 for warp and No. 20 for woof for plain white blankets. To give the color patterns, either one or a combination of the following yarns is used: red Nos. 24 and 30, yellow 26, green 26, orange 26, imported blue 20, Mañgaldan blue 20, and Mañgaldan black 20. Of the different yarns used, unbleached No. 10 has the largest threads. Yarns with practically the same size of threads are yellow No. 26, green 26, orange 26, and red 30. Yarns which are larger in diameter than the above numbers but practically the same in size are red No. 24, unbleached 20, Mañgaldan blue 20, Mañgaldan black 20, and imported blue 20.

Table 2 shows the average amount and cost of materials used in making one blanket. It required 11.26 hanks of warp valued at ₱0.26, about 14.54 hanks of woof valued at ₱0.52, and

₱0.06 worth of thread and yarn for *plecos*[4] to weave one blanket approximately 2.60 meters long and 1.80 meters wide, or a total of ₱0.84. The cost of materials per blanket was highest for first class blankets, amounting to ₱0.95, second highest for second class blankets, ₱0.89, and lowest for third class blankets, ₱0.70. First class blankets required a greater amount of warp and woof than any of the lower quality blankets because threads were woven very close. The value of *plecos* and thread required per blanket was the same for the first and second classes of blankets, ₱0.08, and much higher than that required for making one blanket of the third class, which amounted to ₱0.03 only.

Labor cost. The number of weavers employed depends upon the number of looms; usually there was one weaver to a loom. The present survey covered 20 weavers of first class blankets,[5] 51 of second class,[5] and 89 of third class,[5] or a total of 60 weavers.

The wages of weavers vary according to the quality of blanket made. Weavers are paid by the piece, not by the day. The wages of weavers of first class blankets averaged ₱0.38, but ranged from ₱0.28 to ₱0.53 per blanket. Weavers of second class blankets received ₱0.23 per blanket, on the average; their wages varied from ₱0.20 to ₱0.37. Weavers of third class blankets were paid ₱0.16 per blanket, on an average; their wages varied from ₱0.10 to ₱0.20. The average wage per blanket of weavers for all classes of blankets included in the survey was ₱0.26. (See table 1).

Table 4 shows that the average labor cost per blanket represents 21.78 per cent of its total cost. The cost of labor per blanket of the first class represents 27.54 per cent of the total cost of production; that for second class, 19.82 per cent; and that for third class, 17.98 per cent.

Weavers of first class blankets were kept busy for 274.50 days throughout the whole year; weavers of second class, 285.59 days; and weavers of third class, 273.65 days. The length of employment for weavers of all classes of blankets included in the survey averaged 277.91 days. (See table 1).

Capital cost. Capital cost included the cost of the use of the loom and the depreciation of its accessories. The value of the looms used in the weaving of the blankets included in the survey was obtained by evaluating the cost price of each of the different accessories of the different looms used in weaving.

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[4] The border braid, or fringe, of a blanket

[5] Refers to the amount of yarns used in weaving a blanket. Generally, first class blankets are heavier than either second or third class.

The value of the looms varied with the quality of blankets woven. The average value of each loom used in making first class blankets was ₱11.70; second class, ₱11.14; and third class, ₱10.49. The average value of each loom for all classes of blankets included in the survey was ₱11.11. (See table 6).

Since the loom is used from year to year without any apparent decrease in value, no depreciation was charged. Instead, the cost of accessories, such as heddles and reeds, which usually get worn out and need to be changed from time to time, was computed and considered as cost of the use of loom. Table 3 shows the cost of the use of looms. For all classes of blankets, it averaged ₱0.0317 per blanket. The cost of the use of loom per blanket was, for first class, ₱0.0381; for second class, ₱0.0320; and for third class, ₱0.0249. This may be explained by the fact that the cost of heddles and reeds was higher for first class blankets than for the lower classes.

Summary and distribution of the cost of production. Table 4 shows the summary and distribution of the costs of production per blanket. The average total cost of production per blanket for all classes was ₱1.13, distributed as follows: use of loom, ₱0.03, or 2.65 per cent of total cost; materials, ₱0.84, or 74.34 per cent; labor, ₱0.26, or 23.01 per cent. It may be seen, therefore, that of the elements of cost, materials constituted the highest percentage; labor, second; and capital, lowest. The average total cost of production per blanket for the different classes was ₱1.37 for first class blankets; ₱1.15, second class; and ₱0.88, third class.

Labor income. It was found that 8 to 10 hours are needed for weaving one first class blanket, or an average of 9.4 hours. It takes from 7 to 9 hours to weave one second class blanket, or an average of 7.37 hours, and from 5 to 8 hours for one third class blanket, or an average of 6.73 hours. Table 1a shows that the average weaver produced 296.95 first class blankets in 274.50 days, or 1.08 blankets a day; 422.12 second class in 285.59 days, or 1.48 blankets a day; and 505.73 third class in 273.65 days, or 1.84 blankets a day. At a wage of ₱0.38 per blanket, the average weaver of first class blankets, working 274.50 days, received a daily income of ₱0.41, or ₱112.65 a year. The average weaver of second class blankets, receiving a wage of ₱0.23 per blanket and working 285.59 days during the year, had a daily income of ₱0.34, or ₱97.21 a year. The average weaver of third class blankets, receiving a wage of ₱0.16 per blanket and working 273.65 days during the year, had an income of ₱0.29 a day, or ₱80.56 a year. These figures show that the highest labor income is obtained from weaving first class blankets, second highest from second class, and lowest from third class.

The weavers of blankets in Bangar, La Union, do not observe any regular hours of work daily. Some of them may start weaving early in the morning and continue working until midnight, stopping only when they eat their three regular meals. Others may start weaving after they have finished their chores in the morning and continue this work until it is time for cooking the noon meal. These types of weavers return to weaving after dinner and continue the work until the time for cooking the supper arrives. After supper, they weave again until about nine o'clock, when they are ready to go to bed. Still others may start weaving one day, then leave the work for some more urgent task, such as washing the family clothes, and will not return to weaving until the work is done. When the more urgent work has been finished, they go back to weaving. There are times of the year, especially during the months of December, January, and February, when the weavers are very busy. During these months they usually work all day and until midnight in order to fill orders. In January and February buyers usually order large quantities of blankets. Some of these are taken to Vigan at the carnival in that town, which occurs during the latter part of January; some are taken to the Cagayan Valley because the dealers take advantage of the presence of cash or palay in the provinces of Cagayan and Isabela. Just after the rice harvest in the northern part of the province of Cagayan, the Ilocano blanket dealers go to that region and barter the blankets for palay, which they take to Ilocos. Some of these dealers go to the southern part of the province and to Isabela to sell their blankets because at this time of the year the farmers are actively engaged in selling their tobacco. When their tobacco has been sold, the farmers in that region become good customers. Many buyers also order more blankets in January than ordinarily and take them to Manila to be sold at the carnival in the latter part of February.

On the other hand, there are times during the year when the weavers of Bangar are practically idle. These are during the months of June and July, the planting season, and during October, November, and the early part of December, the harvesting season for rice.

The weavers either go out to work on farms for wages or help their husbands on the family farms during the planting and harvesting seasons.

Terms of sale

Weavers of blankets covered by this survey sold their product for cash only. This is because they need the cash for purchasing raw materials.

Methods of marketing

Direct method. The only known method of direct marketing is the sale by the weavers to final consumers at the municipal market. Since local and traveling buyers make purchases at the municipal market, not all sales at this place of business go to final consumers. Direct sales at weavers' homes are possible but, because final consumers and dealers could not be differentiated, this method of sale was not considered in this study.

Table 7 shows the amount of direct sale at the municipal market. There were a total of 38,518 blankets of all classes sold in the municipal market, or 55.82 per cent of all blankets sold. Of this number, 3,669, or 61.78 per cent of the total in this group of sales, were first class blankets; 11,648, or 54.11 per cent, second class; and 23,201, or 51.55 per cent, third class.

Indirect method. This method consists of sales to local and traveling buyers which generally take place in the weavers' homes. Table 7 shows the amount of sales under this method. There were 22,225 blankets of all classes sold to local buyers, or 26.68 per cent of all blankets sold. There were 1,210 first class blankets, or 20.37 per cent in this group of sales; 5,348 second class, or 24.84 per cent; and 15,667 third class, or 34.81 per cent, sold to local buyers at the homes of the weavers.

There was a total of 11,734 blankets of all classes sold to the traveling buyers, or 17.49 per cent of all blankets sold. Of this number, 1,060 were first class blankets, or 17.85 per cent of the total number in this group of sales; 4,532, second class, or 21.05 per cent; and 6,142, third class, or 13.64 per cent. These traveling and local buyers may be buying for capitalists either in Manila or in the large towns of northern and central Luzon or they may buy and sell for themselves. They sell to retail stores in the city of Manila or in the large towns in the provinces in northern and central Luzon.

Channels of distribution in the marketing of Bangar blankets

The result of the survey showed that Bangar blankets pass through from one to three dealers in their journey from the weavers to the final consumers. The outlets for the native woven blankets of Bangar, La Union, are the municipal market, local buyers, traveling buyers, and retail stores.

Means of transportation

Man power. Human labor is commonly employed in transporting blankets to the municipal market of Bangar. The blankets are placed in big baskets (tampipi) or wrapped in cloth and carried on the heads of the weavers to the market. Traveling buyers, too, generally carry them wrapped in cloth while peddling their goods.

Horse-drawn vehicles. Carretelas or carromatas are sometimes used by the weavers to transport the blankets to the local market. When carretelas are used, the weavers usually pay the owners of these vehicles a flat rate of ₱0.04 per hundred blankets, regardless of the quality of the products.

Trucks or automobiles. Passenger buses and the railroad are also used by traveling buyers in transporting their purchases from the weavers or from the local municipal market at Bangar to their own towns or to large markets.

Cost of marketing

In general, marketing costs include handling at local points, transportation, handling by the various classes of dealers, including repacking, storage, damage, and delivery to retailers, and handling through retail stores, including delivery to consumers.

In this survey, the itemizing of the cost of marketing was found to be difficult as the weavers and dealers interviewed did not have any records of the expenses incurred in the different processes of marketing. The prices received by the weavers from the dealers, however, and those paid by the consumers were available. Hence, the cost of marketing as discussed in this work is represented by the difference in percentage between the price received by the weavers and that paid by the consumers. The price paid by the consumers, which in this case is considered to be the price of the goods as retailed in Manila, is considered as 100 per cent. The difference between this and the proportion of it received by the weaver represents the percentage of the final price consumed by marketing cost.

Prices received by the weavers. The survey shows that the weavers of blankets in Bangar, La Union, sold their products to the consumers in the municipal market, to local buyers who might sell the products to other middlemen, and to traveling buyers who usually took the goods to various places outside of the province of La Union. The average price received per blanket by the weavers of Bangar was as follows: for first class, ₱2.02 a piece; second class, ₱1.21; and third class, ₱0.93. (See table 8).

On the assumption that buyers in the municipal market are final consumers of blankets in the locality, these prices are considered as consumer's prices. Since the average cost of production of first class blankets was ₱1.37 a piece, the weavers of first class blankets made an average gross profit of ₱0.65 per blanket. Weavers of second class blankets made an average gross profit of ₱0.06 per blanket, inasmuch as the cost of producing this type of blankets averaged ₱1.15 each. Weavers of third class blankets made an average gross profit of ₱0.05 per blanket, their cost of production being, on the average, ₱0.88 for each blanket.

Since a considerable amount of Bangar blankets are sold in Manila, the prices there may be considered as typical of the consumer's prices of those Bangar blankets which reach consumers outside of the province of La Union. If the price of blankets in Manila is considered as 100 per cent, the weavers of Bangar received 80.80 per cent of the final price of first class blankets produced, 76.22 per cent of that of second class, and 58.12 per cent of that of the third class. The cost of marketing and middlemen's profit for the first class blankets is ₱0.48, or 19.20 per cent of the final price; for second class blankets, ₱0.59, or 32.78 per cent; and for third class, ₱0.67, or 41.88 per cent. The above figures indicate that middlemen handling Bangar blankets in Manila made the largest profit from the third class blankets, the second largest profit from the second class blankets, and the least gain from the first class blankets. On the other hand, the weavers received a larger portion of the consumer's price of the first class blankets than that of either second or third class blankets.

Table 7 shows a comparison of the different methods of marketing Bangar blankets employed by the weavers. The 20 weavers of first class blankets interviewed sold 3,669 blankets, or 61.78 per cent of 5,939 blankets produced, at the municipal market of the town. The total selling price of these blankets amounted to ₱7,513.65, and the cost of producing them, ₱5,064.69; the gross profit was ₱2,448.96.

The total sales of these weavers to local buyers amounted to 1,210 blankets, or 20.37 per cent of the total production. These were produced at a cost of ₱1,657.70 and sold for ₱2,355.75. The gross profit was ₱698.05. The same weavers sold 1,060 blankets, or 17.85 per cent of their total production, to traveling buyers at ₱2,115.45. It cost ₱1,452.20 to produce these blankets; hence, they brought to the weavers a gross profit of ₱663.25.

The 51 weavers of second class blankets interviewed sold 11,648 blankets at the municipal market for ₱14,381.75, or 51.11 per cent of 21,528 blankets, their total production. The total cost of producing these blankets was ₱13,516.34. Selling them at the local market, therefore, brought to the weavers a gross profit of ₱865.41. The same weavers also sold to local buyers 5,348 blankets, or 24.84 per cent of the total, for ₱6,224.80. Since it cost ₱6,159.20 to produce these blankets, therefore, the weavers realized a gross profit of ₱74.60. There were 4,532 blankets, or 21.05 per cent of the total, sold by the weavers to traveling buyers for ₱5,358.25. The gross profit of the weavers from these blankets amounted to ₱145.45. (See table 7).

The 89 weavers of third class blankets sold 23,201 blankets, or 51.55 per cent of 45,010 blankets, their total production, at the municipal market for ₱22,226.00. The cost of producing these blankets was ₱20,658.17. Therefore, the weavers realized from their sale at the municipal market a gross profit of ₱1,567.83. There were also 15,667 blankets, or 34.81 per cent of the total, sold to local buyers for ₱13,840.88. The cost of production of these blankets amounted to ₱13,786.96. The weavers thus realized from this sale a gross profit of ₱53.84. Forty-five of these weavers sold some of their products to taveling buyers, amounting to 5,142 blankets, or 13.64 per cent of the total, for ₱5,785.68. The cost of production of these blankets was ₱5,404.96. The sale gave a gross profit to the weavers of ₱380.72. (See table 7).

It is seen from the foregoing figures that from the point of view of the weavers, it was advantageous to produce first class blankets for sale. They made more money from this type of blankets, especially when they sold them at the local municipal market directly to consumers, than from the second and third class blankets. It is, therefore, more advantageous for the weavers to produce these high quality blankets than to spend their time weaving blankets of second and third class, which give them very little gain but from which the middlemen make much profit. If the weavers of Bangar, however, insist on weaving second and third class blankets, it would be to their advantage to sell these directly to the large retail stores in Manila or to other large markets. By doing this, they would be able to receive about ₱1.80 per blanket of the second class and ₱1.60 per blanket of the third class, instead of only ₱1.21 and ₱0.93 each for the second and third class blankets, respectively, as they are now doing.

Middlemen's margin. There was no middlemen's margin for those blankets which the weavers sold at the Bangar municipal market and to local and traveling buyers at their homes because the sales involved direct marketing. Some of the blankets, however, bought by the local and traveling buyers reach places outside of the province of La Union. For Bangar blankets reaching Manila, the middlemen's margin can roughly be determined. Table 8 shows the middlemen's margin per blanket for the different classes included in the survey, with the price quoted in Manila considered as final consumer's price. The middlemen's margin per blanket of the first class is ₱0.48, or 19.20 per cent of the consumer's price; for blankets of the second class, ₱0.59, or 32.78 per cent of the consumer's price; and for blankets of the third class, ₱0.67, or 41.88 per cent. This margin includes the dealer's profit and the total marketing expenses. Since middlemen dealing in the purchase and sale of blankets of the second and third classes make more profit from these types of blankets than those dealing in first class blankets, it is possible for the weavers of the inferior quality blankets to increase their share of the consumer's price. This may be accomplished through the sale of these blankets by a co-operative association among the weavers or by any other system which would enable the weavers to reach the final consumer through the least number of middlemen.

Financing marketing operations

From personal funds of weavers. Practically all of the 160 weavers included in this study furnished their own capital to purchase the raw materials for making blankets. The wages of the weavers are paid out of the cash price received from each blanket turned out and sold.

From advances of buyers. None of the 160 weavers interviewed had any occasion to receive money advanced by buyers to defray expenses in the weaving of blankets. This was probably due to the fact that the production of each weaver is not very much. Moreover, it has been the custom in the place to sell the products of the weavers for cash.

RELATION OF THE WEAVING INDUSTRY TO FARMING

To determine to what extent the cloth weaving industry of Bangar is dependent upon locally grown cotton for its raw materials, the weavers were asked about the sources of the yarns which they used for making blankets. Of the 160 weavers interviewed none used yarns made from locally grown cotton fiber. They declared that there are few farmers in the remote barrios of Bangar who produce small quantities of cotton, as a side line, but the wives of these farmers make yarns out of the locally produced cotton fiber for weaving cloths for making kimonos, shirts, and shorts for members of their families. They do not use the fiber for weaving cloth for commercial purposes because it is more costly than the imported fiber. There is, therefore, no direct relationship between the blanket weaving industry in Bangar and the local cotton growing.

There is, however, an indirect relationship between this household industry and farming in the locality in general. The weaving industry and farming in Bangar may be said to be complementary. No detailed and accurate facts have been obtained in connection with this phase of the work, but certain pertinent facts and general information from the weavers tend to bring out this conclusion. The Census of 1918 indicates that the town of Bangar, La Union has a population of 10,923 and 8,164 farms, or one farm for every 1.33 persons. The farms in the town cover a total area of 2,268 hectares, of which 1,979 hectares are cultivated, or an average of 0.242 of a hectare of cultivated area per farm. This area is too small to give an income sufficient to furnish the average family, of say five persons, with its primary needs. It can be said, therefore, that the women of that town engage themselves in weaving cloth for commercial purposes in order to supplement the income of their families from the small farms they own.

Information from the weavers themselves tend to confirm the foregoing statement. The 160 weavers included in the survey declared that they do very little weaving during the planting and harvesting of rice. During the planting season, the weavers go out to the farms of their husbands or relatives to help plant rice. After this season is over, they go back to their household industry. When the harvesting season comes, they again go to the farms and help harvest the rice crop. After harvesting they return to weaving again. Figures showing actual working days of the weavers spent in weaving indicate that they have time for helping their husbands or other members of their families on the farms. Table 1a shows that the average weaver of blankets in Bangar spends from 273.65 to 285.59 days during the year for weaving. This leaves her from 79.41 to 91.35 days free to help on the farm. The income of the average weaver of blankets in Bangar ranges from ₱80.56 to ₱112.65 per year. This is too small to support the weaver and the members of her family. But by helping on the farm, the average weaver assures herself and her family not only food but also money from weaving to buy other things that the family may need.

SUMMARY AND CONCLUSIONS

1. The average cost of production of blankets woven in Bangar, La Union, based on a total of 72,477 blankets of all classes, was ₱1.13. This consisted of ₱0.03, or 2.65 per cent, as representing the cost of the use of loom; ₱0.84, or 74.34 per cent, raw materials; ₱0.26, or 23.01 per cent, labor. The average cost of production per blanket of the first class, based on a total of 5,939 blankets, was ₱1.37; of the second class, based on a total of 21,528 blankets, ₱1.15; and of the third class, based on a total of 45,010 blankets, ₱0.88.

2. Blankets woven by natives of Bangar, La Union, were sold for cash.

3. Native woven blankets of Bangar, La Union, passed through the hands of from one to three middlemen in their journey from the weavers to the consumers.

4. The outlets for native woven blankets of Bangar, La Union, were the consumers who bought the products directly from weavers at the municipal market; the local buyers who bought the blankets from the weavers' homes, sold them at the municipal market, and also peddled them to consumers in other towns in and outside of the province; and the traveling buyers who bought them at the weavers' homes, sold them in the larger markets outside of the province, and also peddled them to retail stores.

5. The price received per blanket by the weavers of Bangar, La Union, was as follows: for first class blankets, ₱2.02; for second class, ₱1.21; and for third class, ₱0.93. If it is assumed that these are consumers' prices, then the weavers of first class blankets made a gross profit of ₱0.65 per blanket; those of second class, ₱0.06; and those of third class, ₱0.05. The price of blankets at the local municipal market determined the price received by the Bangar weavers. The retail price of Bangar blankets according to quality in Manila was as follows: for first class blankets, per piece, ₱2.50; for second class, ₱1.80; and for third class, ₱1.60. If the Manila price is con-

sidered as a typical final consumer's price for these types of goods, the weavers of the first class blankets in Bangar received 80.80 per cent of the consumer's price; those of the second class, 67.22 per cent; and those of the third class, 58.12 per cent.

The middlemen's margin for first class blankets was ₱0.48, or 19.20 per cent; that for second class, ₱0.59, or 32.78 per cent; and that for third class, ₱0.67, or 41.88 per cent.

Under the above conditions, it appears that it would be to the advantage of the weavers of Bangar to produce only first class blankets. If they continue manufacturing the lower quality blankets, however, they may increase their share of the consumer's price by a more direct method of marketing. The organization of a cooperative marketing association among the weavers would help increase their share of the consumer's price and thus reduce the margin of the middlemen.

6. The grading of blankets according to established procedure has shown results greatly to the advantage of both labor and producer. The fact that blankets of the first class sold at a higher price than those of the second and blankets of the second at a higher price than those of the third indicates that better quality goods command higher prices on the market. This suggests the possibilities that can be brought about by the enforcement of grading rules and the standardization of established grades for goods produced for commercial purposes.

The advantage of a higher price for high quality goods is also reflected in the income of labor employed in the production of blankets in Bangar, La Union. Weavers of first class blankets received ₱0.38 for every blanket finished; those of second class, ₱0.23; and those of third class, ₱0.16. Based on average production per weaver of 1.08 blankets of the first class per day and on 274.5 days employed for weaving during the year, the income of the average weaver of first class blanket was ₱0.4104 per day, or ₱112.65 per year. The average weaver of second class blankets, producing 1.48 blankets per day and working 285.59 days during the year, obtained an income of ₱0.3404 per day, or ₱97.21 per year. The average weaver of third class blankets, producing 1.84 blankets per day and working 275.65 days during the year, received an income of ₱0.29 per day, or ₱80.56 per year.

7. The weavers of blankets for commercial purposes in Bangar, La Union, use only imported cotton yarns, since they claim that these are cheaper than those produced from locally grown cotton fiber.

There is, however, a small amount of home-grown cotton fiber used in the weaving of cloths for home consumption. This shows that the commercial weaving of cloths in Bangar has no direct relationship with the local growing of cotton in the locality.

The activities of the weavers of blankets in Bangar, La Union, seem to indicate, however, that this household industry and farming in the locality, in general, are complementary. The average weaver of blankets in the town spends from 273.65 to 285.59 days during the year in weaving and the rest of the time, from 79.41 to 91.35 days, in helping the family plant and harvest rice on the small family farm. Since the produce from such a small farm is insufficient to provide for the needs of the family, the women spend the greater part of their time in weaving in order to earn money to supplement the family income from the farm.

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TABLE 1

Wage, days employed for production, and number of blankets produced in one year in Bangar, La Union
(1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF WEAVERS	WAGE PER BLANKET		NUMBER OF DAYS EMPLOYED FOR PRODUCTION		AVERAGE NUMBER OF BLANKETS PRODUCED	
		Range	Average per weaver	Range	Average per blanket	Total	Average per weaver
		pesos	*pesos*				
First class	20	0.28–0.53	0.38	200–320	274.50	5,939	296.95
Second ”	51	0.20–0.37	0.23	150–310	285.59	21,528	422.12
Third ”	89	0.10–0.20	0.16	216–305	273.65	45,010	505.73
Total	160	0.58–1.10	0.77	566–935	833.74	72,477	1,224.80
Average ..	—	0.19–0.37	0.26	189–312	277.91	—	408.27

TABLE 1a

Labor per blanket and labor income computed on the basis of number of blankets per weaver in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF WEAVERS	HOURS PER WEAVER PER BLANKET		AVERAGE NUMBER OF DAYS FOR WEAVING PER YEAR	AVERAGE NUMBER OF BLANKETS PER WEAVER PER YEAR	AVERAGE NUMBER OF BLANKETS PER WEAVER PER DAY	AVERAGE WAGE PER BLANKET	COMPUTED LABOR INCOME PER WEAVER	
		Range	Average					Per day	Per year
							pesos	*pesos*	*pesos*
First class	20	8–10	9.4000	274.50	296.95	1.08	0.38	0.4104	112.65
Second ”	51	7–9	7.3725	285.59	422.12	1.48	0.23	0.3404	97.21
Third ”	89	5–8	6.7303	273.65	505.73	1.84	0.16	0.2944	80.56

TABLE 2

Cost of materials per blanket produced in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	WARP (GANAY) PER BLANKET		WOOF (PACAN) PER BLANKET		PLECOS AND THREAD PER BLANKET	TOTAL COST OF MATERIAL PER BLANKET
	Amount	Value	Amount	Value	Value	
	hanks [a]	*pesos*	*hanks*	*pesos*	*pesos*	*pesos*
First class	12.05	0.28	16.50	0.59	0.08	0.95
Second "	11.69	0.27	14.82	0.54	0.08	0.89
Third "	10.03	0.23	12.29	0.44	0.03	0.70
Total	33.77	0.78	43.61	1.57	0.19	2.54
Average ..	11.26	0.26	14.54	0.52	0.06	0.84

[a] A hank of cotton yarn is a coil or skein of 840 yards.

TABLE 3

Average cost of use of loom per blanket produced in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF BLANKETS PER WEAVER PER YEAR	NUMBER OF HEDDLES PER YEAR	COST OF HEDDLES PER BLANKET	NUMBER OF REEDS PER YEAR	COST OF REED PER BLANKET	TOTAL COST OF USE OF LOOM PER BLANKET
			pesos		*pesos*	*pesos*
First class	296.95	45.30	0.0364	1.75	0.0017	0.0381
Second "	422.12	57.21	0.0304	2.53	0.0016	0.0320
Third "	505.73	40.71	0.0234	2.75	0.0015	0.0249
Total	1224.80	143.22	0.0902	7.03	0.0048	0.0950
Average ..	408.27	47.74	0.0306	2.34	0.0016	0.0317

TABLE 4

Summary of cost of production per blanket in Bangar, La Union
(1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF BLANKETS PRODUCED		USE OF LOOM PER BLANKET		MATERIALS PER BLANKET		LABOR PER BLANKET		AVERAGE TOTAL COST OF PRODUCTION PER BLANKET
	Total	Average per weaver	Total	Per cent of total	Total	Per cent of total	Total	Per cent of total	
			pesos		*pesos*		*pesos*		*pesos*
First class	5,939	296.95	0.04	2.92	0.95	69.34	0.38	27.74	1.37
Second ”	21,528	422.12	0.03	2.61	0.89	77.39	0.23	20.00	1.15
Third ”	45,010	505.73	0.02	2.27	0.70	79.55	0.16	18.18	0.88
Total	72,477	1,224.80	0.09	7.80	2.54	226.28	0.77	65.92	3.40
Average ...	—	408.27	0.03	2.65	0.84	74.34	0.26	23.01	1.13

TABLE 5

Summary of total costs of production of blankets covered by the survey in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF BLANKETS PRODUCED	USE OF LOOM	MATERIALS	LABOR	TOTAL COST OF PRODUCTION
		pesos	*pesos*	*pesos*	*pesos*
First class	5,939	237.56	5,642.05	2,256.82	8,136.43
Second "	21,528	645.84	19,159.92	4,951.44	24,757.20
Third "	45,010	900.20	31,507.00	7,201.60	39,608.80
Total	72,477	1,783.60	56,308.97	14,409.86	72,502.43
Average ..	—	594.53	18,769.66	4,803.29	24,167.48

TABLE 6

Cost, selling price, and profit of blankets covered by the survey in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF LOOMS USED	AVERAGE COST PER LOOM	NUMBER OF WEAVERS	NUMBER OF BLANKETS PRODUCED	PRODUCTION COST *a*		SELLING PRICE OF BLANKET		GROSS PROFIT	
					Total	Average per blanket	Total	Average per blanket	Total	Average per blanket
		pesos			*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
First class	20	11.70	20	5,939	8,136.43	1.37	11,984.85	2.02	3,848.42	0.65
Second "	51	11.14	51	21,528	24,757.20	1.15	25,964.80	1.21	1,217.60	0.06
Third "	89	10.49	89	45.010	39,608.80	0.88	41,852.56	0.93	2,247.76	0.05
Total	160	33.33	160	72,477	72,502.43	3.40	79,802.21	4.16	6,899.19	0.76
Average ..	—	11.11	—	24,159	24,167.48	1.13	26,600.74	1.38	2,299.73	0.25

[a] The only cost of marketing borne by the weavers was the ₱0.01 per blanket which they paid for the privilege of selling at the municipal market and the ₱0.04 per 100 blankets which they paid for transporting the products from their homes to the municipal market.

TABLE 7

Comparison of different methods of marketing blankets produced in Bangar, La Union (1935–1936)

BLANKETS (TRAMBIA AND ALIPUSPUS)	NUMBER OF WEAVERS	NUMBER OF BLANKETS SOLD	BLANKETS SOLD						To local buyers	
			At municipal market							
			Number of blankets	Per cent of total	Selling price	Cost of blankets *a*	Gross profit		Number of blankets	Per cent of total
							Total	Average per weaver		
					pesos	*pesos*	*pesos*	*pesos*		
First class	20	5,939	3,669	61.78	7,513.65	5,064.69	2,448.96	122.45	1,210	20.37
Second ”	51	21,528	11,648	54.11	14,381.75	13,516.34	865.41	16.97	5,348	24.84
Third ”	89	45,010	23,201	51.55	22,226.00	20,658.17	1,567.83	17.62	15,667	34.81
Total	160	72 477	38,518	55.82	44,121.40	39,239.20	4,882.20	157.04	22,225	26.68

a Including actual production and marketing costs

BLANKETS (TRAMBIA AND ALIPUSPUS)	BLANKETS SOLD									
	To local buyers				To traveling buyers					
	Selling price	Cost of blankets	Gross profit		Number of blankets	Per cent of total	Selling price	Cost of blankets	Gross profit	
			Total	Average per weaver					Total	Average per weaver
	pesos	*pesos*	*pesos*	*pesos*			*pesos*	*pesos*	*pesos*	*pesos*
First class	2,355.75	1,657.70	698.05	34.90	1,060	17.85	2,115.45	1,452.20	663.25	8.31
Second ”	6,224.80	6,150.20	74.60	1.46	4,532	21.05	5,358.25	5,211.80	146.45	4.87
Third ”	13,840.80	13,786.96	53.84	1.20	6,142 *b*	13.64	5,785.68	5,404.96	380.72	4.28
Total	22,421.40	21,594.86	826.49	37.56	11,734	17.48	13,259.38	12,068.96	1,190.42	15.46

b Only 45 weavers sold blankets to traveling buyers.

TABLE 8

Middlemen's margin

BLANKETS (TRAMBIA AND ALIPUSPUS)	RETAIL PRICE (CONSUMER'S PRICE) = 100%, PER BLANKET	PRICE RECEIVED BY WEAVER		MARGIN OF MIDDLEMEN	
		Amount per blanket	Per cent of consumer's price	Amount per blanket	Per cent of consumer's price
	pesos	*pesos*		*pesos*	
First class	2.50	2.02	80.80	0.48	19.20
Second "	1.80	1.21	67.22	0.59	32.78
Third "	1.60	0.93	58.12	0.67	41.88

LIBERATION OF COCONUT OIL THROUGH BACTERIAL AGENCY [1]

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In the summer of 1933 one of us (de Leon), in the course of the laboratory work on foods and feeds, and with the coöperation of Mr. R. A. Cruz, formerly of this Department, attempted to study the effect of dilution alone on the separation of oil from coconut milk ordinarily called "*gata*." On one occasion, because of lack of time to prepare adequately the necessary containers, an old glass carboy in which *gata* had been placed the day before was used in making a trial. After it had been washed and rinsed with tap water, it was filled with a new batch of milk. The yield of oil obtained, compared with the previous trials in which all the containers had been scrubbed with an acid cleaning mixture, then thoroughly washed and dried, was surprisingly high. Repetitions showed that experiments carried on in containers cleaned with acid cleaning mixture gave, if any, a low yield of oil, while those held in containers which had been merely washed and rinsed with tap water resulted in high yields. The possibility of the existence of microörganisms or other agents responsible for the rather high yield, otherwise destroyed by the cleaning mixture, was suggested.

Interest in the problem was enhanced by the fact that the oil obtained was water-white and almost odorless. The possibility that this process of extracting the oil from the coconut milk might lead to the production of an inexpensive oil, which could be used directly for the manufacture of many industrial products requiring a high grade oil, led to a more detailed study of the process. The results so far obtained are herein presented.

METHODS OF EXTRACTING COCONUT OIL

Of the various methods known for extracting the oil from the coconut meat, the expeller is the most common for producing the oil of commerce. This process yields an oil which is colored and rancid, or which quickly becomes rancid, depending on the raw materials used, and because of this it can not be used for many industrial purposes. It has to be bleached and deodorized before it can be used in the manufacture of such articles as hydrogenated oils, pomades, pharmaceutical preparations, etc. The process of bleaching and deodorizing entails additional expense.

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[1] Experiment Station contribution No. 1240. Read before the Los Baños Biological Club, Feb. 27, 1936.

The only methods known to yield a rather water-white oil are: (*a*) using shredded meat instead of copra, and (*b*) de-emulsifying with starch or gelatin and using a supercentrifuge as suggested by Clemente and Villacorte (1933). The supercentrifuge method requires the use of rather expensive equipment.

A new method of recovering the oil from the copra is the use of bacterium. This method was suggested by Beckman (1930). The bacterium he used was *Bacillus delbrueckii.* He claimed to have first isolated the organism from brewer's malt. Beckman's process requires six days for completion and is fully covered by U. S. and foreign patents. The quality of the oil obtained is again dependent on the quality of the copra used. He found an increase in the free-fatty-acid content of the oil at the end of the process.

Harovitz-Vlasova and Novotelnov (1935) tried experiments to test the Beckman method of extracting oils. The method they followed consisted of mixing 20 grams of the material with one gram of calcium carbonate. The mixture was next moistened with 60 ml. of water and the mass inoculated with a culture of *Bacillus delbruekii.* Air was then removed from the flask and the mixture allowed to stand for five days at 55°C. The oil separated and rose to the top from which it could be removed. Of the oil present in the different samples tried, 88.2 per cent could be extracted from copra; 79.8 per cent, from walnut; 78.2 per cent, from cedar nut; 16.5 per cent, from pistachio nut; 16.0 per cent, from sunflower seed; and 0 per cent, from hemp seed, linseed, mustard seed, castor bean, cotton seed, apricot kernel, cherry kernel, and corn germ. When they repeated their experiment and added a certain amount of glucose, the same results were obtained, except in sunflower seed and apricot kernel which yielded 55.0 per cent and 25.9 per cent, respectively. The amount of glucose added was not mentioned. They also found that the oil extracted with the Beckman method had a higher acid value but a lower iodine value than that extracted with ether in the ordinary way.

Theoretical consideration of the process

Coconut milk as extracted from coconut meat is an emulsion of coconut oil, water, sugar, proteins, and salts. The presence of the dissolved salts may account for the fact that even freshly extracted coconut milk conducts electricity. Clemente and Villacorte (1933) found that the proteins are colloidally dispersed at the water-oil interface and that the sugars, which are mostly dissolved in the aqueous phase, act as emulsifying agents. If a means of breaking the emulsion could be found, the oil could be liberated. But such a process, on the other hand, must not in any way affect the quality of the oil.

According to Clayton (1928), a number of technical methods have already been developed for breaking emulsions. These methods are based on the use of antagonistic emulsifiers, centrifugal force, electrical energy, filtration under pressure, and heat treatment. Clemente and Villacorte (1933) claimed to have tried all of these processes and found the one they reported to be the most effective in recovering the entrained oil.

Since the sugars act as emulsifying agents, the problem then is to find a way of recovering the oil without affecting the quality and purity of the product by destroying the materials that act as emulsifiers. If any substance, therefore, could be found which when added to the coconut milk would destroy the sugar only, without affecting the oil, the emulsion might be broken and the oil thus liberated. In the absence of such a substance, the other alternative was to find some organic means in the form of enzymes, bacteria, or other forms of organisms making use of the sugars in the emulsion, thus breaking it and releasing the oil. Such a means of de-emulsification would, in principle, be simple, economical, and easy to operate. A class of organisms which was fairly easy to grow and multiply in cultures has been isolated from the fermenting "gata". This is the de-emulsifying agent used in the oil-recovery process reported herein.

Preparation of the coconut milk

In so far as it was possible, well ripened nuts were used in this investigation. Some of the nuts were bought from stores in the locality, and some collected from the coconut trees of the Department of Agronomy. The Coconut Coöperative Association of San Pablo, Laguna, furnished free of charge the nuts used in the semi-commercial scale production.

The meat in the nuts was shredded at first by means of a native grater. Later on, a revolving grater was used which gave a finer meat. The shredded meat was thoroughly mashed with the hands and the milk squeezed out. A known volume of water was then added to the residue which was mashed and squeezed as before. The process was repeated three times. From the total volume of the milk thus recovered, the volume of water added being known, the quantity of undiluted milk could be calculated. Water was then added to the milk to bring it to the required dilution.

During the latter part of the work a laboratory Carver hydraulic press capable of pressures up to 16,000 pounds to the square inch was acquired by the Department. This was employed to press the milk out of the freshly grated coconut meat for the semi-commercial scale runs. The milk thus expelled was used in the work.

It was found by repeated trials that the best concentration of the coconut milk for the organism was a dilution of approximately 1 : 3. It was at this dilution that all of the trials reported in this paper were made. At a lower dilution the separation of the oil, curd or scum, and water into distinct layers was not well defined. On the other hand, with a dilution higher than three, the fermenting mixture had a very strong tendency to be attacked by molds. Results on this phase of the work are given in tables 1a and 1b.

Preparation of the milk for inoculation

The organisms used in this study were obtained from the scum of fermenting coconut milk which had stood for 48 hours and propagated in sterile nutrient bouillon. Mr. E. F. Roldan, of the Department of Plant Pathology, gave the following morphological description of two of the five cultures isolated by the senior author:

Bacterial culture No. 4

Bacillus sp. Apparently large-sized bacterium; rod-shaped with rounded ends; occurs in culture singly or in pairs, or in chains of as many as four cells; straight, sometimes slightly curved; flagella around the cells number four or more; individual cells measure from 1.7 to 5.7 × 1.07 to 1.4 micra.

Bacterial culture No. 6

Bacillus sp. Large-sized bacillus; slender, rod-shaped with rounded ends; in cultures it occurs singly, in pair, or in chains of four cells; actively motile, with flagella around the cells numbering from a few to many; size of the cells varies from 2.8 to 8.9 × 1.07 to 1.7 micra.

For the inoculation of a batch of coconut milk, a 48- to 72-hour culture in a liquid medium (10 ml. to every 300 ml. milk) of the particular organism was used.

The coconut milk was diluted to the required concentration. It was then divided into equal portions, the number of portions dependent on the number of trials to be made.

One of these portions was transferred to an evaporating dish and the oil recovered by rendering. The amount of oil obtained by this latter process was considered as the approximate theoretical amount of oil recoverable in each of the lots. This process of recovering the oil was carried on in every trial culture, since the amount of oil obtainable was dependent on the quality and degree of ripeness of the nuts, on the amount of pressure used in extracting the coconut milk from the shredded meat, and on the state of sub-division of the meat.

Inoculation of the milk

The cultured organisms were then introduced into each of the other portions which were covered, shaken, and allowed to stand either at ordinary temperature of the laboratory or in an oven kept at 35° to 40°C along with other containers without any added organisms.

It was found that the best temperature for those organisms to do the work was from 30° to 40°C. At this temperature a clear oil layer could be obtained. At a very much lower temperature, especially during the months of December and January in this locality, the oil set free separated as a solid mass, which became mixed with the curd or scum found floating on top of the water layer. After fifteen to twenty hours a clear separation of the oil and the rest of the water and curd was affected.

It was also observed that prolonged contact of the oil with the curd and water resulted in the production of an inferior grade of oil, which had a very peculiar putrid smell. Among the organisms under study, it was observed that one type developed the undesirable odor more quickly and more pronounced than the rest.

Test tubes were used as fermenting containers for the first trials. Then with larger samples, beakers were used. Difficulty in measuring the yield of oil was encountered in the use of these apparatus as fermenting vessels. Two-liter graduated cylinders were next used and measurement of the volume of the oil liberated was effected without the necessity of transferring the oil into other measuring devices. For a semi-commercial scale trial, petroleum cans were used. The cans were provided with openings fitted with small delivery tubes at convenient points near the bottom. This facilitated the drawing off of the water and the oil and left the scum in the can. When patroleum cans are used as fermenting containers, they should be thoroughly cleaned and dried after use; otherwise they get rusty.

Recovery of the oil

At the end of the required period, or as soon as fermentation stopped, as evidenced by the absence of any rapid evolution of gas and by the shrivelled top of the scum, the container was filled with water, (except when cans were used, in which case the oily layer was withdrawn by means of the delivery tubes) and the oily layer poured into a measuring receptable. It was next transferred into a separatory funnel, washed several times with hot water, dehydrated, and filtered. In the absence of a dehydrating agent the washed oil was filtered through a mat of filter cel. Sometimes kieselguhr was used in place of filter cel. The oil thus obtained was not, however, as clear and sparkling as that which had been dehydrated.

The curd which still contained oil was transferred into a beaker and carefully heated until the protein was completely coagulated. By this process of rendering, an additional yield of an inferior grade of oil was obtained. The oil was slightly colored and had a mild nutty odor. The intensity of the color was dependent on the temperature and on the length of time at which the scum was heated.

Quality of the oil recovered

By being rendered, coconut milk yielded an inferior grade of oil. The oil was colored, the shade of color being dependent on the manner in which the boiling had been done. It had a pronounced nutty odor, characteristic of coconut oil. In general, when coconut milk is rendered, the color is more pronounced than that obtained by heating the curd in the fermentation process.

When some of the cultured organisms were introduced into the diluted coconut milk, a water-white coconut oil was obtained. With respect to color, this oil was far superior to oil obtained either by rendering or by the use of expellers. There was practically no, or only a comparatively mild, odor in the oil thus produced.

Sometimes a water-white coconut oil was obtained even when no cultured organisms were introduced into the sample of coconut milk. This was also found by Mr. M. Celino in coöperation with Dr. G. O. Ocfemia, of the Department of Plant Pathology, using 50 and 100 ml. of coconut milk. A material increase in the amount of superior grade coconut oil was, however, obtained when cultured organisms were introduced. In those cases in which a yield of superior grade of oil was obtained in the absence of any introduced cultured organisms, it was possible that organisms capable of liberating water-white oil might have gained entrance into the culture containers. Also, these organisms were isolated from coconut milk; hence, in those cases in which the age of the coconut was favorable and the milk extracted contained all of the nutrients required for favorable growth of these organisms, it is possible that the coconut milk obtained therefrom already had these organisms.

As mentioned elsewhere in this paper, the superior grade of oil obtained by this process was practically odorless and was also negative to the Kries test for rancidity.

DISCUSSION OF RESULTS

The results of several trials are given in tables 2 and 3 and summarized in table 4. Table 2 (laboratory scale) shows the results when 300 to 800 ml. of undiluted coconut milk were fermented; table 3 (semi-commercial scale), when 1000 to 3000 ml. of coconut milk were used.

It is readily seen in table 2 that when the milk was fermented in the presence of the cultured organisms, the yield of superior grade coconut oil was materially increased from 24.79 per cent to 59.92 per cent, while the yield of this grade of oil in the absence of organisms was very much less. In a trial where 50.46 per cent of superior grade was obtained, despite the fact that no organisms were introduced, the result may be due to the presence of some organisms either left over in the container from a previous experiment or naturally occurring in the coconut milk as explained before. A parallel run with organisms in this same trial yielded 59.92 per cent of superior grade of oil.

It has been observed that in all cases in which the cultured organisms were used, an increased yield of superior grade of oil and a corresponding decrease of the inferior grade resulted.

The yield of inferior grade of oil (obtained from heating the curd) when the organism was introduced ranged from 1.83 to 9.23 per cent, while in the absence of the organism the yield was from 9.14 to 47.12 per cent. This grade of oil was identical with that obtained by rendering. The total yield of oil in those cases in which organisms were introduced was slightly higher than that obtained by rendering. This result was probably due to the fact that some oil was lost by spattering during boiling while some adhered to the resulting curd.

Identical trend of results was also found when a greater volume (semi-commercial scale) of coconut milk was employed, as shown in table 3. The yield of superior grade, when organisms were introduced, ranged from 20.42 to 38.40 per cent, while in the absence of any introduced organisms the yield ranged from 0 to 20.10 per cent. The yield of inferior grade, when organisms were introduced, was materially decreased. Rendering, as in previous cases, only yielded an inferior grade of oil. The results also suggest that the method is applicable to semi-commercial and most likely to commercial scale.

The aqueous layer resulting from the fermentation of the coconut milk when properly evaporated gave a residue which was very sticky. This may be recovered as a by-product of this process, if a use for it could be found.

The composition of the curd

Table 6 shows the proximate composition of the curd obtained by rendering and by fermentation.

It was found that the curd in the samples in which the bacteria were used for the recovery of the oil was devoid of sugar and starch. It is possible that all of the carbohydrates in the coconut milk were utilized by the bacteria during the process. The curd contained a fairly high amount of protein, and it should be studied for its possible feeding value or for the manufacture of putty for woodwork.

CONCLUSIONS

1. A method of liberating oil based on the proper dilution of coconut milk and on the action of bacteria is suggested.
2. The oil obtained was water-white and almost odorless. The yield almost corresponds quantitatively with that from the expeller method.
3. The oil was produced by the de-emulsification of coconut milk after proper dilution and inoculation of bacteria which had been isolated from fermented coconut milk and kept in pure cultures. While oil may be produced in some cases by proper dilution alone of coconut milk, inoculation of the bacteria gave a larger yield of oil.
4. The method was successfully applied on a semi-commercial scale.
5. The high grade of oil obtained suggests the possibility of the oil being used for many industries demanding clear, colorless, and odorless oil.
6. The residue after the aqueous layer has been evaporated suggests new by-products obtainable by this process.

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TABLE 1a

Effect of dilution on the separation of coconut oil from coconut milk[a]

SAMPLE NUMBER	COCONUT MILK	WATER	OIL	REMARKS [b]
	ml.	*ml.*	*ml.*	
1	393	600	75	Oily layer separated after 24 hrs Well defined separation
2	393	1200	70	Oil layer well defined as in 1
3	393	1800	62	Oil layer, moldy and putrid
4	393	2400	58	" " " " "
5	393	3000	47	" " " " "
6	393	3600	45	" " " " "
7	393	4200	40	" " " " "

[a] Coconut meat weighing 3,520 grams was squeezed with water and the gata was divided into equal portions.

[b] Oil samples from 3, 4, 5, 6, and 7 gave positive rancid test using the Kries method.

TABLE 1b

Effect of dilution on the separation of coconut oil from coconut milk[a]

SAMPLE NUMBER	MILK	WATER	OIL	REMARKS
	ml.	*ml.*	*ml.*	
1	380	580	55	Oily layer but not well defined, pleasant odor
2	380	1160	87	Very well defined oily layer, pleasant odor
3	327	1500	80	Defined oily layer, putrid odor
4	380	2320	—	Same odor as 3 and moldy
5	354	2700	—	" " " " " "
6	380	3480	—	" " " " " "
7	380	3960	—	" " " " " "
8	366	4480	—	" " " " " "
9	354	4860	—	" " " " " "
10	362	4000	—	" " " " " "
11	366	6160	—	" " " " " "
12	380	6960	—	" " " " " "
13	65	2100	—	" " " " " "
14[b]	680	—	—	Oily layer not well defined

[a] 600 grams of grated meat were squeezed with water in each trial.

[b] Pure coconut milk, shredded meat pressed without adding water

TABLE 2

Effect of organism on the recovery of oil from coconut milk in a laboratory scale

TREATMENTS	VOLUME OF MILK	WEIGHT OF MILK	YIELD OF SUPERIOR GRADE OF OIL		YIELD OF INFERIOR GRADE OF OIL		TOTAL YIELD
	ml.	*gm.*	*ml.*	*per cent*	*ml.*	*per cent*	*per cent*
With organism (1)	300.0	289.68	160.0	50.26	10.0	3.14	53.40
(2)	300.0	289.68	140.0	43.97	12.0	3.77	47.74
(3)	300.0	289.68	145.0	45.55	15.0	4.71	50.26
(4)	300.0	289.68	160.0	50.26	10.0	3.14	53.40
Average	300.0	289.68	151.2	47.50	11.8	3.71	51.21
No organism	300.0	289.68	0	0	150.0	47.12	47.12
Rendering	300.0	289.68	0	0	124.0	38.96	38.95
With organism (1)	500.0	432.8	305.0	64.12	6.0	1.26	65.38
(1)	500.0	432.8	190.0	39.94	27.0	5.68	45.62
(2)	500.0	432.8	300.0	63.07	1.0	0.21	63.28
(2)	500.0	432.8	265.0	55.71	28.0	5.88	61.59
(3)	500.0	432.8	295.0	62.02	37.0	7.77	69.79
(3)	500.0	432.8	275.0	57.82	8.0	1.68	59.50
(4)	500.0	432.8	310.0	65.18	35.0	7.35	72.53
(4)	500.0	432.8	340.0	71.49			
Average	500.0	432.8	285.0	59.92	20.2	4.24	64.16
No organism	500.0	432.8	260.0	54.67	10.0	2.10	56.77
	500.0	432.8	220.0	46.26	77.0	16.19	62.45
Average	500.0	432.8	240.0	50.46	43.5	9.14	59.60
Rendering	500.0	432.8	0	0	290.0	60.97	60.97
	500.0	432.8	0	0	295.0	62.03	62.03
Average	500.0	432.8	0	0	292.5	61.50	61.50
With organism (1)	500.0	432.8	180.0	37.84	9.0	1.87	39.71
(2)	500.0	432.8	200.0	42.05	7.0	1.47	43.52
(3)	500.0	432.8	200.0	42.05	8.0	1.68	43.73
(4)	500.0	432.8	180.0	37.84	11.0	2.31	40.15
Average	500.0	432.8	190.0	39.94	8.8	1.83	41.79
No organism	500.0	432.8	0	0	206.0	43.31	43.31
Rendering	500.0	432.8	0	0	205.0	43.10	43.10

TABLE 2 (continued)

TREATMENTS	VOLUME OF MILK	WEIGHT OF MILK	YIELD OF SUPERIOR GRADE OF OIL		YIELD OF INFERIOR GRADE OF OIL		TOTAL YIELD
	ml.	*gm.*	*ml.*	*per cent*	*ml.*	*per cent*	*per cent*
With organism (1)	750.0	724.2	320.0	40.21	15.0	1.88	42.09
(2)	750.0	724.2	320.0	40.21	16.0	2.01	42.22
(3)	750.0	724.2	300.0	37.70	23.0	2.89	40.59
(4)	750.0	724.2	360.0	45.23	7.0	0.87	46.10
Average	750.0	724.2	325.0	40.84	15.25	1.92	42.76
No organism	750.0	724.2	0	0	340.0	42.72	42.72
Rendering	750.0	724.2	0	0	275.0	34.55	34.55
With organism (1)	800.0	752.48	215.0	26.00	20.0	2.41	28.41
(2)	800.0	252.48	195.0	24.19	17.0	2.06	26.25
(3)	800.0	752.48	120.0	14.51	77.0	9.31	23.82
(4)	800.0	752.48	290.0	35.07	35.0	4.23	39.30
Average	800.0	752.48	205.0	24.79	37.3	5.51	29.30
No organism	800.0	752.48	16.0	1.93	160.0	19.35	21.28
Rendering	800.0	752.48	0	0	230.0	27.82	27.82
With organism (1)	800.0	752.48	220.0	26.60	85.0	10.27	36.87
(1)	800.0	752.48	210.0	25.40	59.0	7.13	32.53
(2)	800.0	752.48	260.0	31.44	17.0	2.06	33.50
(2)	800.0	752.48	220.0	26.60	90.0	10.78	37.38
(3)	800.0	752.48	185.0	22.37	130.0	15.72	38.09
(3)	800.0	752.48	210.0	25.40	73.0	8.82	34.22
(4)	800.0	752.48	150.0	18.14	122.0	14.75	32.89
(4)	800.0	752.48	230.0	27.81	35.0	4.23	32.04
Average	800.0	752.48	211.2	25.54	76.3	9.23	34.77
No organism	800.0	752.48	45.0	5.45	170.0	20.55	26.00
	800.0	752.48	42.0	5.08	168.0	20.31	25.39
Average	800.0	752.48	43.5	5.27	169.0	20.43	25.70
Rendering	800.0	752.48	0	0	160.0	19.35	19.35

TABLE 3

Effect of organism on the recovery of oil from coconut milk in semi-commercial scale

TREATMENTS	VOLUME OF MILK	WEIGHT OF MILK	YIELD OF SUPERIOR GRADE OF OIL		YIELD OF INFERIOR GRADE OF OIL		TOTAL YIELD
	ml.	*gm.*	*ml.*	*per cent*	*ml.*	*per cent*	*per cent*
With organism (1)	1000.0	965.6	420	39.58	6.0	0.56	40.14
(2)	1000.0	965.6	410	38.65	5.0	0.47	39.12
(3)	1000.0	965.6	420	39.58	5.0	0.47	40.05
(4)	1000.0	965.6	380	35.81	8.0	0.75	36.26
Average	1000.0	965.6	407.5	38.40	6.0	0.56	38.96
No organism	1000.0	965.6	0	0	380.0	35.81	35.81
Rendering	1000.0	965.6	0	0	387.0	36.47	36.47
With organism (1)	1800.0	1738.08	400.0	20.94	28.0	1.46	22.40
(2)	1800.0	1738.08	380.0	19.89	35.0	1.83	21.72
(3)	1800.0	1738.08	380.0	19.89	5.0	0.26	20.15
(4)	1800.0	1738.08	400.0	20.94	5.0	0.26	21.20
Average	1800.0	1738.08	390.0	20.42	18.3	0.96	21.38
No organism	1800.0	1738.08	360.0	18.84	15.0	0.78	19.62
Rendering	1800.0	1738.08	0	0	405.0	21.20	21.20
With organism (1)	3000.0	2896.8	660.0	20.64	540.0	16.96	37.60
(2)	3000.0	2896.8	660.0	20.64	540.0	16.96	37.60
(3)	3000.0	2896.8	680.0	21.36	480.0	15.07	36.43
(4)	3000.0	2896.8	640.0	20.10	400.0	12.57	32.67
Average	3000.0	2896.8	660.0	20.64	490.0	15.39	36.03
No organism	3000.0	2896.8	640.0	20.10	600.0	18.84	38.94
Rendering	3000.0	2896.8	0	0	810.0	25.44	25.44
With organism (1)	3000.0	2896.8	640.0	20.10	360.0	11.31	31.41
(2)	3000.0	2896.8	680.0	21.36	240.0	7.54	28.90
(3)	3000.0	2896.8	690.0	21.67	360.0	11.31	32.98
(4)	3000.0	2896.8	670.0	21.05	300.0	9.42	30.47
Average	3000.0	2896.8	670.0	21.05	315.0	9.89	30.94
No organism	3000.0	2896.8	0	0	960.0	30.15	30.15
Rendering	3000.0	2896.8	0	0	860.0	27.01	27.01

TABLE 4

Average yield of coconut oil by the use of organism, without organism, and rendering in a laboratory and semi-commercial scale

TRIALS	TREATMENTS	VOLUME OF MILK	WEIGHT OF MILK	YIELD OF SUPERIOR GRADE OF OIL		YIELD OF INFERIOR GRADE OF OIL		TOTAL YIELD
		ml.	*gm.*	*ml.*	*per cent*	*ml.*	*per cent*	*per cent*
IX	With organism .	300.0	289.68	151.2	47.50	11.8	3.71	51.21
	No organism . . .	300.0	289.68	0	0	150.0	47.12	47.12
	Rendering	300.0	289.68	0	0	124.0	38.95	28.95
VI	With organism .	500.0	432.8	285.0	59.92	20.2	4.24	64.16
	No organism . . .	500.0	432.8	240.0	50.45	43.5	9.14	59.60
	Rendering	500.0	432.8	0	0	292.5	61.50	61.50
VIII	With organism .	500.0	432.8	190.0	39.94	8.8	1.85	41.79
	No organism . . .	500.0	432.8	0	0	206.0	43.31	43.31
	Rendering	500.0	432.8	0	0	205.0	43.10	43.10
X	With organism .	750.0	724.2	325.0	40.84	15.25	1.92	42.76
	No organism . . .	750.0	724.2	0	0	340.0	42.72	42.72
	Rendering	750.0	724.2	0	0	275.0	34.55	34.55
VII	With organism .	800.0	752.48	205.0	24.79	37.3	4.51	29.30
	No organism . . .	800.0	752.48	16.0	1.93	160.0	19.35	21.28
	Rendering	800.0	752.48	0	0	230.0	27.82	27.82

TABLE 4 (continued)

TRIALS	TREATMENTS	VOLUME OF MILK	WEIGHT OF MILK	YIELD OF SUPERIOR GRADE OF OIL		YIELD OF INFERIOR GRADE OF OIL		TOTAL YIELD
		ml.	*gm.*	*ml.*	*per cent*	*ml.*	*per cent*	*per cent*
XI	With organism .	800.0	752.48	211.2	25.54	76.3	9.23	34.77
	No organism . . .	800.0	752.48	43.5	5.27	169.0	20.43	25.70
	Rendering	800.0	752.48	0	0	160.0	19.35	19.35
XIII	With organism .	1000.0	965.6	407.5	38.40	6.0	0.56	38.96
	No organism . . .	1000.0	965.6	0	0	380.0	35.81	35.81
	Rendering	1000.0	965.6	0	0	387.0	36.47	36.47
XII	With organism .	1800.0	1738.08	390.0	18.3	18.3	0.96	21.38
	No organism . . .	1800.0	1738.08	360.0	18.84	15.0	0.78	19.62
	Rendering	1800.0	1738.08	0	0	405.0	21.20	21.20
XIV	With organism .	3000.0	2896.0	660.0	20.64	490.0	15.39	36.03
	No organism . . .	3000.0	2896.0	640.0	20.10	600.0	18.84	38.94
	Rendering	3000.0	2896.0	0	0	810.0	25.44	25.44
XV	With organism .	3000.0	2896.0	670.0	21.05	315.0	9.89	30.94
	No organism . . .	3000.0	2896.0	670.0	0	960.0	30.15	30.15
	Rendering	3000.0	2896.0	0	0	860.0	27.01	27.01

TABLE 5

Some of the physical and chemical characteristics of the oil obtained by bacterial process and that of a commercial grade of coconut oil from copra

CONSTANT	OIL PROCESS	OIL FROM COPRA
Specific gravity at 29°C.	0.9200	0.9163
Solidifying point (°C)	21.0 — 24.5	18.0 — 19.0
Melting point (°C)	23.0 — 25.5	18.5 — 20.0
Acid value	0.0	3.9
Iodine value	7.74— 8.40	8.4 — 9.06
Saponification value	232.00—256.80	242.00—250.30

TABLE 6

Proximate composition of the fat-free curd

CONSTITUENTS	SOURCE	
	Bacterial process	Rendering
	per cent	*per cent*
Ash	6.89	14.05
Crude fiber	2.60	2.83
Sugar (invert)	0.00	0.32
Starch	0.00	0.00
Crude protein	43.34	40.60

A STUDY OF THE GROWTH HABIT OF RICE PLANTS: I. COMPARISON OF CAN AND FIELD GROWN PLANTS[1]

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WITH THREE TEXT FIGURES

A great deal of work has been done on rice plants grown under "unnatural" conditions of environment, that is, in pots or gasoline cans. A comparative study of the growth habit of rice plants grown in cans and in the field should be of value to researchers.

In this paper, data are presented from two harvests on the tillering habit, booting and flowering times, average height of plants at maturity, diameter and length of a particular internode, number of filled and unfilled grains per panicle, and dimensions of the grains of rice plants in a state of pure line when grown in gasoline cans and in the field.

MATERIALS AND METHODS

Preparation of the land and cans. Approximately twenty square meters of land on the eastern side of the Department of Agricultural Botany building was chosen for this study. In order to keep out destructive animals, a wire fence (¼-inch mesh), 6 feet 4 inches high was built around this area, on top of which a similar wire cover was supported by wooden posts. The plot was divided into two equal lots with about half a meter of ground left untilled around and between them (see fig. 1) to serve as dikes. One of the lots toward the north was dug with a spading fork and mattock. The other toward the south was excavated clear to the hard pan, and all the soil from it was thrown into the first lot. In the excavated lot, the can cultures were placed, whereas in the cultivated lot, the field plants were grown.

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[2] This investigation was made possible by research grant-in-aids from the President of the University of the Philippines and the National Research Council of the Philippine Islands. Mr. Lorenzo Barredo, who was paid from the grant-in-aid of the National Research Council, helped in obtaining most of the data on which the figures herein presented were based.

After the soil in the lot for field plants had been cultivated and thoroughly mixed, tap water from a faucet was run into it for about one week, after which it was puddled and levelled with the feet and a garden hoe. At this time, the ground was considered ready for seeding, although another week elapsed before the seeds were actually sown. The same procedure was followed in the second planting.

Twenty gasoline cans were cleaned, dried, and painted with two coats of dehydrated coal tar. When the paint had dried, the cans were filled with the puddled soil from the lot for field plants to about 10 centimeters from their lids; thus the soil medium was made as uniform as possible in both the field and can cultures. Two holes of about 3 millimeters diameter were made on one side of each gasoline can, one 5 centimeters from the lid, and the other at the surface of the soil. These were intended to keep the level of the irrigation water constant in the cans and to allow drainage. The cans were placed in 5 rows of 4 each in the excavated lot (see fig. 1).

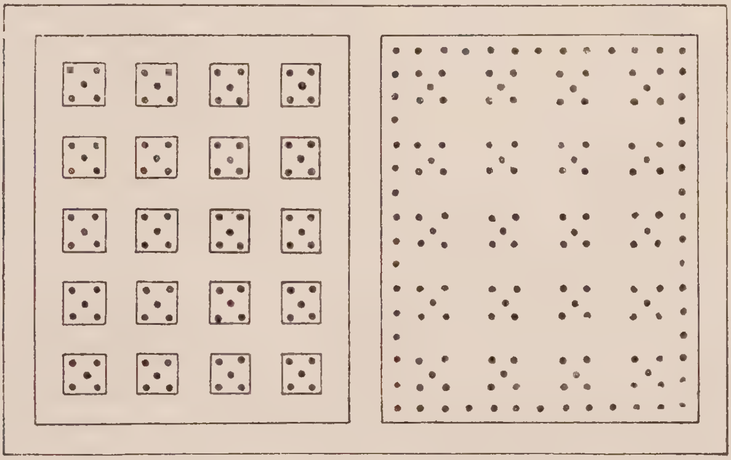

Fig. 1.—Arrangement of lots. Each small square indicates a can, while each dot represents one plant.

Seeding and transplanting. The seeds from three selected panicles of the Guinangang rice, a *palagad*[3] rice variety, obtained on October 15, 1936, from a field in Calamba, Laguna, were separately planted in the prepared ground on November 3, 1936. Previous to sowing, the seeds were soaked in water over-night. The panicle giving the highest percentage of germination was chosen for planting material for this experiment, whereas the seedlings from the other two panicles were utilized as border plants for those seedlings planted in the field. The seeds for the second crop, obtained from the harvest of the first, were sown on August 8, 1937.

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[3] *Palagad* is a group term for rice varieties which could be grown twice a year where irrigation water is available.

The seedlings for the first crop were transplanted on November 14, 1936, eleven days after seeding; those for the second, on August 29, 1937, twenty-one days after seeding. The same method for both crops was used in transplanting. Five seedlings were planted in each can, one in each of the four corners and one in the middle. Those at the corners were about 14.5 centimeters apart and 5.5 centimeters from the sides of the can. For recording, each row of cans, the individual cans, and the plants in each were labelled separately as follows: $R_1C_1H_1$, $R_1C_1H_2$, etc. R represented the row, C, the can, and H, the plant. H_1, H_2, H_3, and H_4 represented the seedlings in the corners, and H_5, the one in the center. In this study, 100 seedlings were included in the can cultures (see fig. 1).

In the field the seedlings were arranged similarly, and care was taken to distance those in the field exactly the same as those in the cans. Border plants were placed around the five rows of plants in the field (see fig. 1). The individual rows, the groups of five seedlings, and seedlings in each group in the field were also separately labelled as follows: $R_1F_1H_1$, $R_1F_1H_2$, etc. R represented the row number, F, the group of five seedlings, and H, the individual plant. The number of plants was also 100.

Irrigation. To irrigate the can and field plants, water was taken from a faucet with a rubber hose. The irrigation water was kept to a depth of five centimeters in both the can and field cultures almost throughout the growing period of the plants. Whenever necessary, it was withdrawn simultaneously from the can and field cultures, and only taken away completely when the plants were nearing maturity.

Weeding. As the cultures were easily accessible, weeding could be done every day, even on Sundays and holidays. The weeds were pulled up by hand whenever any appeared.

Tillering. Weekly counts were made of the number of tillers per plant or hill in both cultures from the two plantings. Observation commenced as soon as the young leaves of the tillers became visible. The counting of tillers in the first planting started on November 30, 1936, just twenty-seven days after seeding and sixteen days after transplanting. In the second planting, the first tiller count was made on September 11, 1937, that is, thirty-four days after seeding and thirteen days after transplanting. Weekly counts of the tillers from can and field cultures of both plantings were continued for some time after booting had taken place. For each of the two plantings, eight weekly counts were made.

Booting and flowering. The time of booting and flowering in all the cultures of the two plantings was carefully recorded.

Harvesting. Inasmuch as data had to be taken separately for each hill from both plantings, harvesting could not possibly be accomplished in a day; in fact, it took no less than a week for all the plants in each planting to be harvested. Before the plants in each hill were cut, the average height of all was taken. This represented the middle reading of the vertical distance between the tallest and lowest panicle in each hill, measuring from the base of each hill to the first nodes of the axes of the panicles. The number of bearing and non-bearing culms was counted; tillers bearing inflorescences at the time of counting, which were either dry because of borers or immature, were considered bearing culms in this study.

The individual panicle from each hill in the first planting was harvested, and each placed in a separate properly labelled paper envelope. These envelopes were then exposed to the sun outside of the laboratory for about two weeks, after which the filled and unfilled grains from the individual panicles were counted in the laboratory. The filled grains in this study included those actually on the panicle at the time of counting and those which had shattered during harvesting and handling the envelopes. The missing grains could be easily determined by counting their pedicels, which usually remained on the panicle. This rice variety has a rather high shattering quality, and it was to be expected that some of the filled grains would fall off. After the filled and unfilled grains from each panicle had been counted, the filled ones were threshed by hand, cleaned, and returned to their respective envelopes for further study.

All the filled grains from the panicles from each hill were then mixed together. Two hundred were taken at random from this mixture, hulled, and their length, breadth, and thickness were measured with a caliper. Only four cans from the first planting provided the seed material for these measurements, which included twenty hills. Corresponding hills grown in the field were similarly treated and measured for comparison. In other words, 8,000 hulled grains, from forty hills, were studied.

A comparative study of the mean length and breadth of hulled grains produced by mother plants and their corresponding tillers was also made. The seed material was obtained from fifty hills from each of the can and field plants of the second harvest. The panicles of fifty mother plants and their corresponding tillers were harvested separately, and their grains were threshed by hand and cleaned thoroughly. Three hundred grains were then taken at random from from each group of harvested grains and hulled. Their length and breadth were measured with a caliper.

An attempt was also made to determine the length and breadth of hulled grains from different portions of panicles of mother plants and their corresponding tillers. Twenty hills from both the can and field plants in the second planting were selected for this study. Panicles from the mother plants were separated from their corresponding tillers and roughly divided into top, middle, and base. Two hundred grains from the three samples were taken at random, hulled, and their length and breadth measured. One thousand two hundred hulled grains were used for each culture, that is, six hundred from the mother plants and another six hundred from their corresponding tillers.

In order to compare the differences between measurements of unhulled and hulled grains, one hundred grain samples taken at random from both top and basal portions of panicles of tillers from the second harvest were weighed on an analytical balance, and each unhulled grain was measured for length and breadth. Then these were hulled by hand and the weight of all the grains was again taken. Measurements of their length and breadth followed.

The diameter and length of an internode of the main axis of the mother plant and its corresponding tillers were determined. The material was obtained from one hundred hills from each of the can and field plants of the second harvest. The internode studied was that one just below the point of attachment of the last leaf, or flag, of the plant. The diameter reading was taken at the middle of the internode and determined with a caliper; its length was measured with a foot ruler.

RESULTS AND DISCUSSION

Tillering

Tillering is a character typical of rice and other cereal crops. Tiller formation in rice takes place within a definite time from either transplanting or broadcasting, and this limiting period is spoken of as the "critical stage" [4] in tiller formation. After this the tillers grow up and produce stems, each with a panicle.

Time of emergence of tillers. Among the material examined, the can and field samples from the first planting showed the youngest leaves of their tillers out of the subtending leaf sheaths at approximately the same time. This was on November 23, 1936, exactly twenty days from seeding and nine days from transplanting. In the second planting, the young leaves of the tillers were visible on September 5, 1937, that is, twenty-six days from seeding and seven days after transplanting. In other words, tillers began to emerge in both plantings at approximately the same time after transplanting, that is, seven to nine days, or within about a week. The older seedlings had a tendency, however, to form tillers earlier.

"Critical stage" in tiller formation. In a study of a number of our local rice varieties, Rodrigo (1924) and Calvo (1927) have found, among other things, that the tillering capacity of rice is governed by various factors, such as, spacing, number of seedlings to the hill, varietal characters, and other environmental conditions. Under normal conditions of cultivation, rice plants begin to tiller a week after transplanting (Banerjee *et al.*, 1936), as found also in this study. In western Bengal, (in early varieties [*aus*]) for example, tiller formation may cease from the fifth or sixth week, but in late varieties it may extend up to the eighth or ninth week. In the United States, rice plants in the field begin to tiller three weeks after seeding (Adair, 1936), and the increase in the number of tillers per plant is very rapid until the end of the sixth week. Tillering may take place after that time, but late tillers usually do not bear panicles, and all that form panicles per plant start growth within a period of three weeks. Ramiah (1927) has observed that the tillering period of rice in India is about three to four weeks in the early varieties and about five weeks in the later ones; that is, late varieties continue to produce tillers till about eight weeks after transplanting. Ramiah and Narashimhan (1936), in a later experiment, report that transplanted rice plants commence active tillering about two weeks after transplanting and will be in full swing for three to five weeks, depending on the duration of the variety.

Table 1 shows the weekly mean increment of tillers per hill in both the can and field plants from the 100 hills in each group of the first planting. In both cultures, a steady increase in the mean number of tillers per plant was found to take place till the forty-seventh day, or approximately within the seventh week from seeding, and thirty-six days, or a little over five weeks from transplanting. This is well illustrated in figure 2. In both cultures, the "critical stage" in tiller formation was reached at the same time, that is, on December 20, 1936. After this a slight increase or decrease was observed, resulting, perhaps, from the death of early or late tillers or from the formation of new late tillers. In fact, the differences of the weekly mean number of tillers per plant in both the can and field plants, after December 20, 1936, were all insignificant. There was, therefore, practically no difference between rice plants grown in cans and those planted in the field in the time necessary to reach their "critical stage" in tiller formation. The difference was even less if the material was a pure line.

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[4] Period needed to produce the maximum number of tillers by the plant (Banerjee *et al*, 1936).

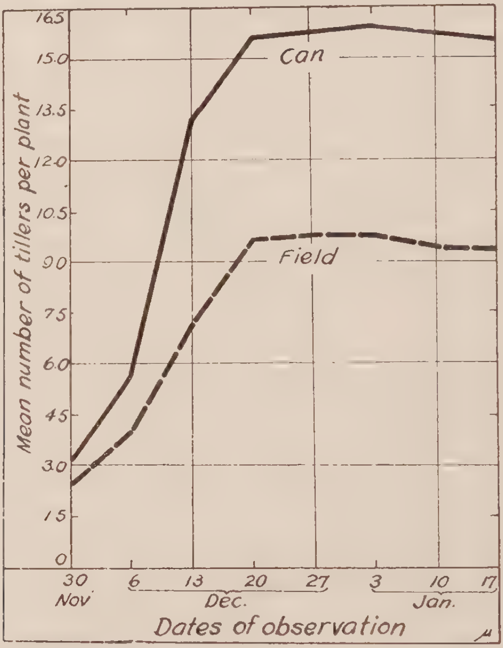

Fig. 2.—Comparative weekly mean increment of tillers per plant

In the second planting, a similar result was obtained. The "critical stage" in tiller formation was reached on October 9, 1937, that is, sixty-two days from seeding and forty-one days from transplanting in both the can and field plants. Why plants from the second planting reached this stage much later than those of the first was perhaps due to the differences in the age of the seedlings at the time of transplantation and to other climatic factors. Seedlings from the first planting were transplanted at the age of eleven days, but those of the second were twenty-one days old. One thing, however, which stood out prominently from the results obtained was that, irrespective of the time of transplanting, rice plants belonging to a single pure variety, whether from can or field cultures, reach the "critical stage" in tiller formation at the same time. From this, it would appear that the "critical stage" in tiller formation of a rice variety is an inherent character, scarcely affected by environmental conditions. The time limit here found further corroborates the findings of Ramiah (1927), Watanabe (1932), Adair (1936), and Ramiah and Narashimhan (1936).

Mean number of tillers from can and field plants. From table 1 and figure 2, one can readily see that the can plants produced more tillers per plant than the field ones, and that the differences between their weekly means were all significant. The ratio between the mean number of tillers of the plants in cans and those in the field was approximately 5 : 3. In the second planting, however, the can plants, although producing more tillers per plant, did not form as many as those in the first planting. The differences between their weekly means were all insignificant (see table 2). The current belief, therefore, that rice plants tiller more in the field than in cans is not confirmed here. This widespread impression may be explained by the fact that under ordinary field conditions of transplanting our rice, more than one seedling or variable numbers of seedlings are planted to the hill, and the combined tillers give one an impression that those planted in the field do tiller more than those in cans. If the average number of tiller is considered, however, it would perhaps be much less per plant than ordinarily supposed—a fact clearly shown by the results of this experiment. Furthermore, if the plants are given identical conditions of environment and the same conditions exist as in this study, those in cans actually tiller more than similar ones in the field, provided they are of the same variety.

The data in table 1 also clearly indicate that variability among plants grown in the field was more pronounced than that among those in the cans. In no case were the coefficients of variation of plants grown in cans higher than those of the plants in the field. On the basis of the figures here presented, one is led to infer that for purposes of more intensive studies in rice, plants grown in cans would afford better material as they are less affected by attendant conditions beyond the control of the experimenter—a fact that is well known to many. Whenever possible, however, a parallel field series should be grown for corroboration.

Mean maximum number of tillers and bearing culms per plant. The yield of a variety depends greatly on its tillering capacity and is, therefore, considered an important economic factor. All tillers, however, are not equally effective in contributing to the final yield; thus, under heavy manuring or very wide spacing, tillers may continue to form until late in the flowering stage, but these do not ripen with the earlier ones and may not yield grains. These late tillers waste much of the energy of the plant without any corresponding return. In a comparative study such as this, it should be of interest to know the mean maximum number of tillers of each plant after reaching the "critical stage" in tiller formation and the mean number of bearing culms.

Table 2 shows the mean maximum number of tillers produced by each plant after the "critical stage" had been reached and their corresponding mean number of tillers producing panicles or bearing culms at maturity. As has been previously stated, plants raised in cans produced a greater mean number of tillers than corresponding ones in the field. In the first planting, the difference between the mean maximum number of tillers produced by plants grown in cans and those in the field was significant, whereas in the second planting, it was insignificant, although the tendency was for plants in cans to produce more tillers than those grown in the field.

In the first planting, the can plants had higher mean number of bearing culms than the field, whereas in the second, both produced nearly identical numbers, and their difference was insignificant. The mortality of the tillers in the can plants was higher, registering nearly 35 per cent, whereas in the field, there was only about 24 per cent. This clearly indicated that there was less waste of energy in producing grains in the field.

It is also shown in table 2 that in the first planting, plants grown in the field were more variable in the production of tillers than those grown in cans, although the difference between their coefficients of variation was insignificant. In the second planting, the reverse was true, although the difference between their coefficients of variations was also insignificant. It will likewise be noted in table 2 that in the first planting, the plants grown in cans produced a significantly greater number of tillers and bearing culms than those grown in the field, whereas in the second planting this difference remained insignificant. The causes responsible for such divergent figures can only be explained perhaps by the difference in existing conditions during the time these plants were growing.

Mean number of tillers and bearing culms in the group of five hills. The tillering capacity of the five hills in each of the cans and their corresponding ones in the field is worth knowing. In table 3 the data obtained from the first harvest give the differences in the mean number of tillers and bearing culms produced by the border hills (H_1, H_2, H_3, and H_4) compared with the central one (H_5). If the mean number of tillers produced by the individual plant in a can is considered, the data show that in two cases out of four the border hills produced a higher mean number of tillers than the central one in the can cultures. In one of these cases, the difference was significant, whereas in the other, insignificant. Among the field plants, in one case out of four the central hill produced less tillers than the peripheral ones, although the difference was insignificant. In the other three cases, the peripheral hills produced smaller mean number of tillers than the central hill, and the differences were all insignificant, indicating, therefore, that all the hills in the group had about the same capacity in producing tillers. It could be inferred, therefore, that in tiller production, the five hills in the cans were as nearly identical and produced nearly the same mean number of tillers, with only one exception, as those in the field.

The mean number of bearing culms produced by the plants in each can was decidedly in favor of the central hill, as in only one out of four cases did the border hills produce a higher mean number of bearing culms than the former in the can cultures. The central hill actually gave a decidedly higher mean number of bearing culms than the border hills; two out of these three cases were significant. On the contrary, the central hill produced more bearing culms in two out of four cases in the field, whereas the other two showed a marked increase in bearing culms in favor of the border hills; all the differences of their means were insignificant. These results clearly show that the five hills, irrespective of their positions in this experiment, produced nearly the same number of bearing culms in the field, but not in the cans. This was to be expected because plants in cans were more exposed to destructive factors than their sisters in the field; the central hills by virtue of their positions in the cans were perhaps more isolated and protected by their four border hills, and hence, could produce more mean bearing culms. Besides, as the peripheral hills were in close contact with the sides of the cans, they were given less space for the expansion of their root systems, which were subjected to greater fluctuations of temperatures than those from the central hills.

Average height

Casual observations show that plants grown in the field are much taller than similar ones in cans, and this fact is confirmed by data from the two harvests in table 4. The mean average heights of the field plants were all significantly greater than those of the can plants. In the first planting, the can plants showed a higher degree of variability in height, and much more in the second, when the plants were visited by typhoons in October and November, 1937, during which time the plants were booting and flowering.

Diameter and length of an internode

The diameter and length of the internode below the attachment of the last leaf or flag of the mother plants and their corresponding tillers were measured on material from the second harvest. The diameter was measured midway between the two nodes with a caliper, and its length with a foot ruler. To distinguish the mother plant from its corresponding tillers, the former was tagged when about 10 centimeters tall and before its tillers were well developed. Data presented in table 5 show the mean diameter in millimeters and length in centimeters of this particular internode of mother plants and their corresponding tillers from both the can and field plants.

This internode of mother plants in the field had a larger mean diameter and length than that in the cans. This was also true of their tillers; all the differences between their means were significant. Such was to be expected as plants grown in the field were significantly taller than similar ones in the cans, as has been previously proved.

If the tillers and their mother plants are to be compared, the latter showed a higher mean diameter and length of this internode than the former, and all the differences between their means were significant, whether the plants were grown in cans or in the field.

Booting and flowering

In general, booting and flowering in both field and can plants from either plantings took place simultaneously. Plants grown in cans from the first planting booted on January 12, 1937, that is, fifty-nine days after transplanting, whereas those in the field, a day later. Plants in cans from the second planting booted on October 28, 1937, that is, sixty days after transplanting, whereas those in the field, only a day later also. Although plants grown in the field showed a tendency to boot later than similar ones in cans, the difference of a day could not be considered great enough for statistical consideration. It seems that booting time in this variety is fixed, immaterial of the date of transplanting and season of planting.

The first panicles of the can plants from the first planting appeared on January 20, 1937, that is, sixty-eight days after transplanting, whereas those in the field appeared on January 21, 1937, or a day later. In the second planting, the can plants showed their first panicles on November 5, 1937, that is, sixty-eight days from transplanting, whereas the field plants showed theirs on November 6, 1937, also a day later. In general, it took about a week for all the inflorescences of the tillers to emerge from their flags, and the mother plants actually bloomed earlier than their corresponding tillers. This was also observed by Ramiah and Narashimhan (1936) to be true in India. Sethi *et al* (1936) found that flowering duration was affected by age of the seedling, even in a pure line, although the mean flowering duration varied slightly with the date of transplanting.

Filled and unfilled grains

The number of filled grains per panicle is a good index of the amount of harvest to be obtained from rice plants. This is, however, dependent on the weather conditions during the ripening stage of the panicles. Because the second harvest suffered from three successive typhoons during its flowering and ripening stages, the data presented here were obtained solely from the first harvest.

Table 6 gives the mean number of filled and unfilled grains per panicle produced by the field and can plants from the first harvest. These data were based on forty hills each from the two cultures. The mean number of filled grains per panicle was significantly higher in the field plants than in the can; that is, panicles obtained from plants grown in the field gave a higher number of filled grains than those in the cans. On the other hand, the mean number of unfilled grains per panicle in the can plants was higher than that in the field. If the mean number of filled and unfilled grains per panicle were to be added, and if this sum would represent the total number of spikelets produced per panicle, it could be seen that the can plants would yield a much lower number of spikelets per panicle than the field ones. Furthermore, if the size of the panicle is directly proportional to the number of spikelets it bears, then results herein presented show that panicles produced by plants grown in cans were much smaller than those from plants in the field. Even though this was so, the can plants were able to form more bearing culms than the field, and any deficiency the former had in their mean number of spikelets per panicle was overcome by the increase in the mean number of bearing culms. In other words, grain production per panicle was significantly higher in plants grown in the field than in their sister plants in cans (see fig. 3), not only because plants grown in the field produced larger panicles, but also they had a lower mean number of unfilled grains, under the conditions of this study. The fact, therefore, that plants grown in the field actually yield more per panicle than similar ones in cans is herein confirmed.

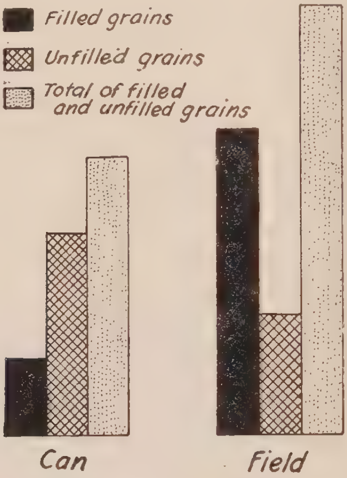

Fig. 3.—Relative characteristics of panicles

Size of grains

Among the quantitative characters of the rice plant known to be least affected by environment and for that reason utilized by various workers in their attempt at classification of cultivated rices (Kikkawa, 1912; Beale, 1927; Thadani and Dutt, 1928; Sethi and Saxena, 1930; Mitra and Ganguli, 1932; Hector *et al*, 1934; Gustchin, 1934; Ram and Chetty, 1934; Ram and Ekbote, 1936; and Piacco, 1936) is the size of the grain. In a study of inheritance of grain-size character, a knowledge of how dimensions may vary in a non-inherited manner is desireable (Tin, 1936); much more is this true when the plants are not grown in the field.

In a statistical study like this, the size of the population to be measured is of great importance. Lord and Abeyesundra (1929) conclude that a minimum of twenty grains is necessary, whereas Ramiah and Parthasarathi (1933) find a six-grain sample obtained from the top and middle of a panicle satisfactory for inheritance study. Tin (1936) believes that at least 100 grains should be measured to give reliable results. Codd and Peterkin (1936) state that it is not necessary to measure more than 200 grains in order to evaluate satisfactorily the dimensional variability of a particular sample of rice grains, and these authors further believe that hulled grains are more consistent than unhulled. In this paper, samples ranging from 100 to 200 grains at any one time and in most cases hulled, rather than unhulled grains were measured, except in one instance where an attempt was made to evaluate the possible relationships between measurements of unhulled and hulled grains obtained from different portions of the panicle, as discussed elsewhere in this paper.

Size of hulled grains from field and can plants. Ramiah and Parthasarathi (1933) state that the dimensional characters of the grain do not vary within a pure line to any appreciable extent. Tin (1936), on the other hand, finds that grain length from different panicles of one plant differ from one another significantly, and in more than half of the comparisons, he obtained significant results. Significant differences have also been found between the means of panicles of different plants. When each panicle is compared with its respective plant means, they show in most cases significant differences, and most of the means of the panicles lay outside the limits of their respective plant means. Significant differences are also shown between the means of plants of the same class. In other words, variation within a plant and within a variety are definite, even in stabilized agrotypes which have been grown in pure cultures for a number of years in the same place and under identical conditions. Ramiah and Parthasarathi (1933) find that grains in the different tillers of the same plant do not vary significantly in size—a fact not confirmed by Tin (1936).

Twenty hills from the cans and a corresponding twenty from the field of the first planting were taken at random, and all the grains harvested from each hill were cleaned and mixed together. From this mixture, a random sample of 200 grains was hulled and measured in length, breadth, and thickness. In this measurement, a total of 8,000 hulled grains were studied, 4,000 from the field plants and another 4,000 from the can. The results are shown in table 7.

Data herein presented show that the mean length of hulled grains from the can plants was less than that from the field plants, and the difference between their means was insignificant. The mean breadth of hulled grains from the can plants was significatly greater than that of the can. In thickness, hulled grains from the field plants showed a significant but slight increase over those of the can. In other words, hulled grains from the field plants were slightly longer and thicker than those from the can, but the latter produced significantly broader grains.

Of the dimensions of the hulled grains, the length was the least variable in the can plants, as shown by their coefficients of variation, whereas thickness was the most variable of the three characters. Breadth, however, was the least variable in the field plants, and thickness was also the most variable of the three. It seems that in a quantitative measurement of grain dimensions, thickness was the least dependable of the dimensions herein considered, whereas length and breadth were nearly equally dependable. Punyasingh[5], however, in his measurements of unhulled grains of several local and exotic rice varieties, found length the most dependable of the three grain dimensions.

The samples from the can plants showed the least variability in all three dimensions of the hulled grains, and the differences between their coefficients of variation were all insignificant and in favor of the can plants.

When the means of the samples obtained from the individual hills, either in the field or can, were compared with the mean of the whole population as given in table 7, these were found to lie mostly outside the limits of the general mean of the whole population, and their differences were, in most cases, significant, a result similar to that obtained by Tin (1936), where the means of the individual panicle also generally showed significant differences, and most of the means of the panicles lay outside the limits of their respective plant means. If the means of the individual hills in this study were compared with one another, significant differences were also found in some cases. These findings, however, do not invalidate the use of dimensional characters of the hulled grains in rice classification inasmuch as the differences between their means were rather small, and in two cases out of three insignificant.

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[5] PUNYASINGH, K. A study of the varietal crosses of Siamese rices, introduced in the College of Agriculture, and their F_1 progeny. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1938. Unpublished).

Mean length and breadth of hulled grains from two harvests. Ramiah and Parthasarathi (1933) state that the size of the grains in rice obtained from crops grown in different months of the same year under Coimbatore conditions does not show a big variation, although in sowings of certain months, the grain-size difference appears to be significant. Van der Stok (1910) reports that within a pure line, size and weight of grains depend on the size of the panicle and fertility of the soil. Tin (1936) finds that the differences in the degree of variability from year to year in grain length were not significant, except in one case. This same author, however, claims that the soil and season have definite effects on grain size. Because of the high winds during the 1937 harvest at the time the young grains were developing, an opportunity was given to evaluate the probable effects of this factor on grain size. Comparable measurements on the mean length and breadth of hulled grains harvested from plants grown in 1936 and 1937 are shown in table 8.

The mean length of hulled grains from both the field and can plants of the 1936 harvest was more than that of the 1937, and the difference between their means was significant. The same was true of the mean breadth. Weather conditions had some profound effect, perhaps, on the development of the pistils after pollination, hence, the marked differences herein exhibited by their grains. Probably, had it not been for such unexpected strong winds, the difference in their means would not have been so pronounced. In such a case, the findings of Tin (1936) would hold true; that is, the differences in variability in grain length from year to year would not be significant.

Mother plants and their corresponding tillers. There is a general belief among our farmers, based mostly on casual observation, that grains produced by the mother plant are larger than those developed by its tillers. Seeds from the mother plants, however, have been found to possess nearly equal yielding power to those from their tillers (Unite, 1921). To prove or disprove this contention, the writer selected fifty hills from each of the can and field plants from the second harvest. In order to be sure that the mother plants could be identified from their corresponding tillers, the former were tagged a week after transplanting. The panicles from the mother plants and their corresponding tillers were harvested separately, and care was taken that no mixtures occurred. The grains obtained from fifty mother plants and their tillers were separately threshed by hand. Samples of 300 grains from each lot were taken at random, hulled, and their length and breadth measured. The results are shown in table 9.

The mean length of the hulled grains from the mother plants in the field was significantly larger than that of their tillers. This was also true of plants from the cans. The mean breadth of the hulled grains from the mother plants was also significantly greater than that of their tillers in the field. The mean breadth of the grains from the mother plants was very slightly larger than that of their tillers in the cans, and the difference between them was insignificant. In other words, the hulled grains of the mother plants seemed larger in both length and breadth than those obtained from their tillers, whether the plants were grown in cans or field. It may be mentioned that Unite (1921) found no significant difference in the mean weight of unhulled grains by mother plants and their tillers, although those from the former tended to be slightly heavier. The belief, therefore, of our farmers is herein confirmed.

From a comparison of the mean length and breadth of hulled grains of mother plants from the field and cans, the data presented in table 9 further show that the former exhibited greater mean length and breadth than the latter. This was also true of their tillers. Statistically, their differences were all significant, but the actual differences in their means (length and breadth) were negligible. For example, the differences in the mean length of mother plants, as given in table 9, were 35 to 51 microns, whereas in the breadth, 37 to 43 microns; in the tillers, they were 22 to 42 microns in mean length and 17 to 23 microns in mean breadth. Hence, it can be readily seen that the difference is too small to make size of grains of value in classification of our rices.

Grain size as affected by position on panicle. Tin (1936), and Ramiah and Parthasarathi (1933), as well as van der Stok (1910), found that there are significant differences in grain length between the top and bottom portions within a panicle; and although the means in other cases do not differ significantly, it appears that a relationship exists between the position on the panicle and grain length, as the latter decreases towards the base of the panicle. It should be stated now that these investigators only measured unhulled grains, and their conclusions were based purely on such material. Furthermore, it was noted that the mean grain weight of unhulled grains decreases downwards on the panicle (van der Stok, 1910), and that the lower portion of the panicle bears a higher percentage of empty grains (van der Stok, 1910; Ramiah and Parthasarathi, 1933).

Accordingly, twenty-five hills from each of the two cultures were selected before the second planting was harvested and the panicles produced by the mother plants and their corresponding tillers were separately and carefully harvested. Panicles from each set were then dried in the sun for three consecutive days and roughly divided into top, middle, and basal portions. These seeds were then carefully threshed by hand, cleaned, and dried again in the sun for about a week outside the laboratory. Samples of 200 grains taken at random from each of the three portions of the panicle from both mother plants and tillers were hulled, and their two dimensions measured. Results are given in table 10.

(*a*) *Mother plants.* If the mean length of hulled grains obtained from the top of the panicles from the mother plants of both cultures are compared with those from the middle and basal portions of the panicle, under the conditions in this experiment, the following generalizations can be drawn: (*1*) The mean length of hulled grains at the top was insignificantly less than that of those found at the middle and significantly less than those at the base in the panicle of plants grown in the field, whereas the mean length at the top was significantly less than at the middle and the base, too, in plants grown in cans; (*2*) the mean length of the middle hulled grains was significantly less than that of the base in plants grown in the field, but the middle hulled grains from the cans was insignificantly longer than those at the base; (*3*) the longest grains were found in the basal portion of the panicle in plants grown in the field, whereas in can-grown plants the longest grains tended to be at the middle. This result is contrary to what had been reported by van der Stok (1910), Ramiah and Parthasarathi (1933), and Tin (1936) when they measured unhulled grains. Tin (1936) says that the mean length of the unhulled grains at the top and middle portions of the panicle did not show significant differences, and that the lower portion of the panicle bore more unfilled grains than the upper. The present writer agrees with Tin's last statement, as he observed the same in all the panicles harvested in both cultures of the two plantings, whether from mother plants or their corresponding tillers.

The mean breadth of top hulled grains in plants grown in the field was insignificantly less than the middle, and significantly more than the base. In the can-grown plants, however, the same trend of size variation in mean breadth was observed. In these plants, the top was significantly narrower than the middle, and significantly broader than the base, and the middle was also significantly broader than the base. In other words, although the shortest grains are at the top, the broadest of them all are at the middle.

In actual weight, the hundred hulled grains (3.6504 grams) at the top of the panicle from field-grown plants were heavier than those at the base (3.6493 grams) and the middle (3.5300 grams), whereas those at the middle were lighter than those at the base of the panicle. In the can plants, however, the top hulled grains (3.6494 grams) weighed more than the middle (3.6004 grams) and the base (3.5796 grams), and the lightest grains were found to be at the base of the panicle. The tendency was for the heaviest grains (based on 100-hulled-grain samples) to be at the top, and the lightest, at the base of the panicle. This agrees with what has been reported by van der Stok (1910), Ramiah and Parthasarathi (1933), and Tin (1936) for unhulled grains.

(*b*) *Tillers.* The tillers exhibited nearly identical results with those obtained from the mother plants in both cultures. In the field plants, the top hulled grains were significantly shorter than those at the middle and the base, whereas the middle were insignificantly shorter than the base. In the can plants, however, the top hulled grains were insignificantly longer than the middle and insignificantly shorter than the base, whereas the middle were significantly shorter than the base. Again in the tillers, the longst grains tended to be confined at the base of the panicle, while the top grains were either shorter or longer than the middle.

In mean breadth, the top hulled grains of the panicle from plants grown in the field were significantly broader than the middle and base, while the middle were insignificantly narrower than the base. In the can plants, the top hulled grains were insignificantly broader than the middle and the base, while the middle were also insignificantly broader than the base. It is evident that among the tillers in both cultures, the broadest grains were found at the top of the panicle, whereas the narrower hulled grains were either at the middle or at the base. In other words, what had been exhibited by the hulled grains in the mother plants was followed to some extent by those produced in their corresponding tillers.

The actual weight of one hundred hulled grains from the top (3.6210 grams) of the panicle in field grown plants was less than that of the middle (3.6493 grams), but heavier than that at the base (3.4000 grams). In the can plants, the top hulled grains (3.6414 grams) were lighter than those at the middle (3.6999 grams) and the base (3.6499 grams). In both cultures, the heavest grains per hundred hulled grains were found to be at the middle.

The reason the longest grains in the panicle tended to show less weight than those shorter ones in the panicle, whether the plants were grown in the field or in cans, must be sought in the difference in the amount of reserve food in the endosperm or in the difference in the size of embryos in the hulled grains. The writer, however, was not able to determine definitely which of these two factors contributed greatly to the actual increase of weight of hulled grains in the top portion of the panicle where these grains were found to be the shortest.

Dimensions of unhulled and hulled grains. Between the data in table 10 and what Tin (1936) concluded about the decrease in grain length and in weight of unhulled grains from the top of the panicle downward, a very confusing situation was created. To throw some light on the results presented above, and to corroborate further the meaning of the findings of Tin (1936), the writer attempted to compare data obtained from unhulled and hulled grains. Samples of one hundred unhulled grains from the top and basal portions of the panicles of tillers from the can plants of the second harvest were taken at random. These were weighed on a sensitive analytical balance, and their length and breadth obtained. These same samples were then hulled, and the total weight again taken. The length and breadth were then measured.

The data presented in table 11 show that the unhulled grains at the top of the panicle were insignificantly longer than those at the base, whereas in mean breadth the former were also insignificantly broader than the latter. The tendency, however, was for the unhulled grains at the top of the panicle to be longer and broader than those at the base. The results given by Tin (1936) that grains tend to be shorter from the top of the panicle downward is herein confirmed, although, as the data show, the differences between their means were insignificant.

The weight of unhulled grains from the top of the panicle per hundred-grain sample was more than of those at the base of the panicle, and this result again confirms the findings and observations of Tin (1936) and van der Stok (1910).

When this same grain sample was hulled, it was revealed that those at the top of the panicle showed insignificantly less mean length and significantly more breadth than those at the base. It seems apparent (see table 10 and 11) that although the mean length of unhulled grains decreases from the tops of the panicle downward, that of the hulled grains increases in the same direction, and distinct negative correlation is hereby exhibited.

The weight of one hundred hulled grains from the top of the panicle was higher than the weight of those at the base; thus the data presented in table 10 were confirmed. The weights of the hundred-grain samples, unhulled or hulled, followed the same course; that is, grains at the top were heavier than those at the base.

The volume of the one hundred hulled-grain sample was determined by the water displacement method. Because the same sample could not be used in the determination of the volume by this method before the grains were hulled owing to the probable effect of water on the enclosed kernels, a similar hundred-grain sample was obtained from the original samples, and the volume of the hundred unhulled grains was determined as above. It was found (see table 11) that the volume of both the unhulled and hulled grains from the top of the panicle was greater than of those at the basal portion of the same panicle.

In the foregoing discussion, it was revealed that the mean length and breadth of unhulled grains, as well as their weight, decrease downward on the panicle. It was further shown that the mean breadth and weight of hulled grains also decrease downward on the panicle, whereas the mean length increases in the same direction. In volume, there was also a tendency for the grains, unhulled or hulled, to decrease downward on the panicle (see table 11). Why the mean length of hulled grains should increase downward on the panicle, and their mean breadth, weight and volume decrease can perhaps be explained as follows: If the weight of the hundred hulled-grain sample (see table 11) is subtracted from that previous to hulling, a difference of 0.5098 grams from the grains at the top of the panicle and 0.4697 grams from the base would be obtained; these represent the weights of the hulls thus removed. In other words, the weight of the hulls from the grains at the top of the panicle was more than that at the base per unit sample, and if this increase in weight represents development either in thickness or amount of silica deposition, then those figures would indicate that hulls of grains at the top of the panicle are more developed and thicker than those at the base. Morphological studies reveal that in the paleas of mature rice grains, the thickest portion is found at or around the apex (apiculus) (Juliano and Aldama, 1937). Based on this fact, it can be assumed that following an increased development of the hull, a decrease in the longitudinal space to be found enclosed by the paleas, hence, a decrease in length of the developing pistil within would result. In other words, the accelerated development of the hull on the top grains as shown by the data presented in table 11, would be followed by a decrease in mean length of the kernel, as brought out by the results obtained by the writer, and any deficiency in growth in length must be overcome by the maximum expansion in breadth of the same pistil. This is, perhaps, why the topmost grains of the panicle tend to be shorter but broader than those at the base.

Codd and Peterkin (1933) concluded that the dimensions of hulled grains were more consistent than of the unhulled ones. Data presented in table 11 do not bear this out very conclusively. While the coefficient of variation may be low in the case of mean length of hulled grains from samples taken at the top of the panicle, the data show that it is high in the case of mean length of unhulled grains from the base of the panicle.

SUMMARY

The present investigation deals with the growth habit of Guinangang rice plants when grown in cans and in the field. The results obtained may be summarized as follows:

1. Irrespective of the season and date of transplanting, rice plants reach their "critical stage" in tiller formation at the same time, whether they be grown in cans or in the field. This stage falls within the fifth to the sixth week from transplanting.

2. Plants grown in cans produced significantly more tillers than those planted in the field; the former consequently produced a significantly greater number of bearing culms than the latter.

3. The field-grown plants in a group of five hills had nearly identical capacity in tiller formation and production of bearing culms, whereas the can-grown ones had nearly the same power of producing tillers, but the central hills tended to form more bearing culms than the peripheral ones.

4. Plants grown in the field were significantly taller than those grown in cans in the two plantings. This was shown in mean diameter and mean length of the internode below the insertion of the flag in the field and can plants.

5. The time of booting and flowering did not seem to be altered by age of the seedlings at the time of transplanting whether the

plants were planted in cans or direct in the field. In general, all inflorescences of the tillers took about a week to emerge from their flags, and the mother plants actually bloomed earlier than their corresponding tillers.

6. The field-grown plants produced significantly less unfilled grains and more filled grains per panicle than the can-grown ones. If the total number of unfilled and filled grains be used as an index of the size of the panicle that bears them, the field-grown plants produced larger panicles than the can-grown, although the latter developed more, but much smaller, panicles per plant than the former.

7. Of the three dimensional characters of hulled grains studied, length tended to be more consistent than thickness. Not much difference was obtained between grains from can and field plants. In breadth, the field plants showed a slight significant increase over the can, whereas the latter showed a significant increase in thickness over the former. When the mean length of each hill was compared with that of the whole population, the former usually lay mostly outside the limits of the latter, and their differences were in most cases significant. Typhoons had a detrimental effect on the grain dimensions as shown by a decrease in the mean length, breadth, and thickness of hulled grains.

8. Mother plants, whether grown in the field or in cans, showed a significantly greater mean length and breadth of their hulled grains than their tillers, although the actual differences were small.

9. The longest hulled grains were found mostly at the basal portion of the panicle, whether the plants were grown in cans or in the field, in both mother plants and their corresponding tillers. There was more variation in breadth, but the tendency was for the broadest grains to be at the top, whereas the narrowest were either at the middle or base of the panicle. The heaviest grains were found at the top, and the lightest, at the base. The conclusion of other workers that the size of unhulled grain decreases from the top downward on the panicle is herein confirmed. The weight of both unhulled and hulled grains also followed the same trend; that is, it decreased downward on the panicle. The volume of hulled and unhulled grains at the top of the panicle was greater than the volume of those at the base, and the weight of hulls of grains at the top was more than of those at the base.

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TABLE 1

Analysis of weekly increment of tillers per plant

DATES OF OBSERVATIONS	MEAN		MEAN DIFFERENCE	STANDARD DEVIATION		COEFFICIENT OF VARIATION		DIFFERENCE OF COEFFICIENT OF VARIATION
	Can	Field		Can	Field	Can	Field	
Nov. 30, 1936	3.10±0.04	2.59±0.05	0.51±0.06	0.55±0.03	0.63±0.04	17.74±0.87	24.48±1.15	6.74±1.44
Dec. 6, 1936	5.54±0.08	3.59±0.07	0.25±0.10	1.16±0.06	0.91±0.05	20.88±1.03	25.40±1.29	4.52±1.65
Dec. 13, 1936	13.03±0.15	6.97±0.18	7.07±0.23	2.15±0.10	2.23±0.12	16.50±0.81	31.99±1.68	15.49±1.73
Dec. 20, 1936	15.66±0.22	9.57±0.25	6.09±0.33	3.23±0.15	2.17±0.18	20.66±1.03	33.12±1.74	12.46±2.02
Dec. 27, 1936	15.70±0.25	9.61±0.21	6.09±0.33	3.64±0.17	2.69±0.15	23.19±1.16	29.03±1.50	5.84±1.87
Jan. 3, 1937	16.05±0.27	9.60±0.14	6.45±0.30	3.93±0.18	2.72±0.09	24.48±1.24	28.36±1.46	3.88±1.93
Jan. 10, 1937	15.69±0.24	9.36±0.21	6.33±0.32	3.59±0.17	2.68±0.15	22.82±1.14	28.63±1.47	3.81±1.86
Jan. 17, 1937	15.46±0.24	9.35±0.21	6.13±0.32	3.55±0.16	2.65±0.15	22.93±1.15	28.34±1.46	5.41±1.86

TABLE 2

Mean maximum number of tillers and bearing culms per plant

First planting

ITEMS	MAXIMUM NUMBER OF TILLERS		
	Can	Field	Differences
Mean	15.66 ± 0.39	10.13 ± 0.22	5.53 ± 0.45
Standard deviation	3.71 ± 0.28	2.80 ± 0.16	—
Coefficient of variation ..	23.69 ± 1.37	27.65 ± 1.66	3.96 ± 1.91
	MAXIMUM NUMBER OF BEARING CULMS		
Mean	10.25 ± 0.23	7.79 ± 0.22	2.46 ± 0.32
Standard deviation	3.51 ± 0.19	2.24 ± 0.15	—
Coefficient of variation ..	34.28 ± 0.96	35.14 ± 1.10	0.86 ± 1.46

Second planting

ITEMS	MAXIMUM NUMBER OF TILLERS		
	Can	Field	Differences
Mean	8.04 ± 0.21	7.66 ± 0.17	0.38 ± 0.27
Standard deviation	3.09 ± 0.14	2.49 ± 0.12	—
Coefficient of variation ..	38.42 ± 2.09	32.48 ± 1.71	5.94 ± 2.70
	MAXIMUM NUMBER OF BEARING CULMS		
Mean	6.37 ± 0.16	6.24 ± 0.18	0.13 ± 0.24
Standard deviation	2.64 ± 0.12	2.42 ± 0.12	—
Coefficient of variation ..	42.34 ± 2.36	37.94 ± 2.05	4.40 ± 3.13

TABLE 3

Differences in the mean maximum number of tillers and bearing culms per plant between the five plants[a]

CULTURES	TILLERS	BEARING CULMS
Can		
$H_5 - H_1$	− 0.51 ± 0.86	+ 1.64 ± 0.82
$H_5 - H_2$	+ 3.17 ± 0.74[b]	− 3.61 ± 0.77[b]
$H_5 - H_3$	− 1.51 ± 0.64	− 3.11 ± 0.75[b]
$H_5 - H_4$	+ 0.13 ± 0.86	− 0.05 ± 0.87
Field		
$H_5 - H_1$	− 0.14 ± 1.02	− 0.19 ± 0.93
$H_5 - H_2$	− 0.67 ± 1.06	+ 0.65 ± 0.99
$H_5 - H_3$	+ 0.06 ± 0.82	+ 0.57 ± 1.00
$H_5 - H_4$	− 1.41 ± 0.93	− 1.43 ± 1.08

[a] — less than H_5; + more than H_5.

[b] Significant

TABLE 4

Average height in centimeters of plants per hill

FIRST PLANTING

ITEMS	CAN	FIELD	DIFFERENCES
Mean	105.46 ± 0.49	107.59 ± 0.43	2.13 ± 0.65
Standard deviation	4.58 ± 0.35	3.92 ± 0.31	———
Coefficient of variation	4.34 ± 0.33	3.64 ± 0.28	0.70 ± 0.43
SECOND PLANTING			
Mean	104.99 ± 0.59	113.78 ± 0.44	8.79 ± 1.04
Standard deviation	8.78 ± 0.41	6.47 ± 0.31	———
Coefficient of variation	8.38 ± 0.40	5.69 ± 0.27	2.69 ± 0.48

TABLE 5

Mean diameter and length of one internode of mother plant and its tillers

MOTHER PLANT

ITEMS	DIAMETER		
	Can	Field	Differences
	mm.	*mm.*	*mm.*
Mean	4.27 ± 0.05	4.93 ± 0.05	0.66 ± 0.07
Standard deviation	0.50 ± 0.03	0.55 ± 0.04	—
Coefficient of variation	11.62 ± 0.90	11.22 ± 0.85	0.40 ± 1.24
TILLER			
Mean	3.68 ± 0.03	4.13 ± 0.03	0.45 ± 0.04
Standard deviation	0.57 ± 0.01	0.74 ± 0.02	—
Coefficient of variation	15.60 ± 0.68	17.89 ± 0.69	3.29 ± 0.97
Mean difference—mother plant and tillers	0.59 ± 0.06	0.80 ± 0.06	—

MOTHER PLANT

	LENGTH		
	cm.	*cm.*	*cm.*
Mean	31.44 ± 0.05	36.39 ± 0.50	4.95 ± 0.50
Standard deviation	0.48 ± 0.03	5.20 ± 0.35	—
Coefficient of variation	1.53 ± 0.11	14.29 ± 1.33	12.76 ± 1.33
TILLER			
Mean	27.08 ± 0.02	32.05 ± 0.25	4.98 ± 0.25
Standard deviation	0.56 ± 0.01	5.90 ± 0.18	—
Coefficient of variation	2.08 ± 0.06	18.41 ± 0.68	16.33 ± 0.68
Mean difference—mother plant and tillers	4.36 ± 0.05	4.34 ± 0.56	—

TABLE 6

Mean number of filled and unfilled grains per panicle

ITEMS	FILLED GRAINS		
	Can	Field	Differences
Mean	26.64 ± 0.62	101.95 ± 2.15	73.31 ± 2.41
Standard deviation	11.81 ± 0.44	33.41 ± 1.52	—
Coefficient of variation	44.33 ± 1.95	32.77 ± 1.49	11.56 ± 2.45

	UNFILLED GRAINS		
Mean	68.49 ± 1.27	40.63 ± 1.06	27.86 ± 1.65
Standard deviation	24.75 ± 0.90	16.64 ± 0.75	—
Coefficient of variation	36.11 ± 1.84	40.95 ± 2.14	4.84 ± 2.82

TABLE 7

Mean length, breadth, and thickness in millimeters of hulled grains from the first harvest

ITEMS	LENGTH		
	Can	Field	Differences
Mean	6.221 ± 0.0021	6.223 ± 0.0028	0.002 ± 0.0035
Standard deviation	0.205 ± 0.0015	0.250 ± 0.0020	—
Coefficient of variation	3.295 ± 0.0248	4.017 ± 0.0333	0.922 ± 0.0403
	BREADTH		
Mean	2.467 ± 0.0009	2.410 ± 0.0010	0.057 ± 0.0013
Standard deviation	0.082 ± 0.0006	0.093 ± 0.0007	—
Coefficient of variation	3.324 ± 0.0251	3.859 ± 0.0309	0.535 ± 0.0398
	THICKNESS		
Mean	1.685 ± 0.0005	1.688 ± 0.0008	0.003 ± 0.0009
Standard deviation	0.065 ± 0.0005	0.068 ± 0.0005	—
Coefficient of variation	3.857 ± 0.0291	4.028 ± 0.0322	0.171 ± 0.0443

TABLE 8

Mean length and breadth in millimeters of hulled grains from the 1936 and 1937 harvests

ITEMS		1936 HARVEST		1937 HARVEST [a]		DIFFERENCES	
		Length	Breadth	Length	Breadth	Length	Breadth
Mean	Can	6.221 ± 0.0021	2.467 ± 0.0009	6.153 ± 0.0042	2.340 ± 0.0016	0.068 ± 0.0046	0.127 ± 0.0015
	Field	6.223 ± 0.0028	2.410 ± 0.0009	6.208 ± 0.0042	2.370 ± 0.0002	0.015 ± 0.0050	0.040 ± 0.0009
Standard deviation	Can	0.205 ± 0.0015	0.082 ± 0.0006	0.211 ± 0.0029	0.082 ± 0.0011	——	——
	Field	0.250 ± 0.0020	0.093 ± 0.0007	0.219 ± 0.0030	0.077 ± 0.0001	——	——
Coefficient of variation	Can	3.295 ± 0.0248	3.324 ± 0.0251	3.429 ± 0.0489	3.504 ± 0.0482	0.134 ± 0.0548	0.180 ± 0.0543
	Field	4.017 ± 0.0333	3.859 ± 0.0309	3.528 ± 0.0486	3.248 ± 0.0406	0.489 ± 0.0589	0.611 ± 0.0510

[a] Three typhoons visited these plants during their flowering and post-flowering stages.

TABLE 9

Mean length and breadth in millimeters of hulled grains of mother plant and its tiller

ITEMS	FIELD					
	Mother plant		Tiller		Differences	
	Length	Breadth	Length	Breadth	Length	Breadth
Mean	6.227 ± 0.006	2.382 ± 0.002	6.190 ± 0.006	2.359 ± 0.002	0.037 ± 0.008	0.023 ± 0.003
Standard	0.200 ± 0.004	0.077 ± 0.002	0.221 ± 0.004	0.085 ± 0.002	—	—
Coefficient of variation .	3.212 ± 0.063	3.233 ± 0.063	3.570 ± 0.070	3.603 ± 0.070	0.352 ± 0.094	0.370 ± 0.094

ITEMS	CAN					
	Mother plant		Tiller		Differences	
	Length	Breadth	Length	Breadth	Length	Breadth
Mean	6.184 ± 0.006	2.342 ± 0.002	6.156 ± 0.005	2.339 ± 0.002	0.028 ± 0.008	0.003 ± 0.003
Standard	0.211 ± 0.004	0.081 ± 0.002	0.198 ± 0.004	0.083 ± 0.002	—	—
Coefficient of variation .	3.412 ± 0.066	3.459 ± 0.067	3.216 ± 0.063	3.549 ± 0.069	0.196 ± 0.105	0.090 ± 0.096

ITEMS	DIFFERENCES BETWEEN FIELD AND CAN			
	Mother plant		Tiller	
	Length	Breadth	Length	Breadth
Mean	0.043 ± 0.008	0.040 ± 0.003	0.034 ± 0.008	0.020 ± 0.003
Standard	—	—	—	—
Coefficient of variation .	0.200 ± 0.091	0.226 ± 0.092	0.354 ± 0.094	0.054 ± 0.098

TABLE 10

Differences in mean length and breadth in millimeters of hulled grains from different portions of the panicle

ITEMS	FIELD [a]				CAN			
	Mother plant		Tillers		Mother plant		Tillers	
	Length	Breadth	Length	Breadth	Length	Breadth	Length	Breadth
Top-Middle	− 0.007 ± 0.011	− 0.005 ± 0.006	− 0.084 ± 0.011	+ 0.035 ± 0.006	− 0.078 ± 0.013	− 0.003 ± 0.006	+ 0.014 ± 0.013	+ 0.002 ± 0.006
Top-Base	− 0.056 + 0.014	+ 0.025 ± 0.005	− 0.081 ± 0.015	+ 0.027 ± 0.006	− 0.058 ± 0.013	+ 0.004 ± 0.006	− 0.032 ± 0.013	+ 0.011 ± 0.006
Middle-Base	− 0.049 + 0.016	+ 0.030 ± 0.005	− 0.001 ± 0.015	− 0.008 ± 0.006	+ 0.020 ± 0.014	+ 0.013 ± 0.006	− 0.046 ± 0.014	+ 0.009 ± 0.006

[a] Minus sign means the first is smaller than the mean of the second item; plus sign means the first is larger than the mean of the second in the items compared.

TABLE 11

Mean length and breadth in millimeters of unhulled and hulled grains from top and base of panicles from tillers of can plants [a]

ITEMS	TOP			
	Unhulled		Hulled	
	Length	Breadth	Length	Breadth
Mean	8.534 ± 0.019	2.686 ± 0.006	6.057 ± 0.013	2.316 ± 0.005
Standard deviation	0.276 ± 0.013	0.083 ± 0.004	0.192 ± 0.009	0.078 ± 0.004
Coefficient of variation	3.234 ± 0.154	3.090 ± 0.147	3.168 ± 0.151	3.377 ± 0.161
Weight in grams of 100 grains measured	2.3300		1.8202	
Volume in ml. of 100-grain sample	1.95		1.50	

ITEMS	BASE			
	Unhulled		Hulled	
	Length	Breadth	Length	Breadth
Mean	8.495 ± 0.018	2.680 ± 0.006	6.068 ± 0.013	2.281 ± 0.005
Standard deviation	0.263 ± 0.013	0.090 ± 0.004	0.191 ± 0.009	0.070 ± 0.003
Coefficient of variation	3.096 ± 0.148	3.358 ± 0.161	3.142 ± 0.150	3.069 ± 0.146
Weight in grams of 100 grains measured	2.2700		1.8003	
Volume in ml. of 100-grain sample	1.85		1.35	

[a] Actual weights in grams and volumes in cubic centimeters of hundred-grain (unhulled and hulled) samples are included.

TABLE 11 (continued)

ITEMS	DIFFERENCES			
	Unhulled		Hulled	
	Length	Breadth	Length	Breadth
Mean	0.039 ± 0.026	0.006 ± 0.008	0.021 ± 0.018	0.035[a] ± 0.007
Standard deviation	—	—	—	—
Coefficient of variation	0.138 ± 0.214	0.248 ± 0.244	0.020 ± 0.213	0.308 ± 0.217
Weight in grams of 100 grains measured	0.0600		0.0199	
Volume in ml. of 100-grain sample	0.10		0.15	

NOTE: A TRANSPLANTING TOOL[1]

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WITH TWO TEXT FIGURES

Seedlings grown in nursery beds or in seed boxes are usually transplanted with the aid of a trowel. Besides this, a bolo, sharpened stick, or the like is used. These tools have a common shortcoming in that when employed in transplanting seedlings, they may disturb unnecessarily the root systems with the result that the amount of water absorbed by the plants is decreased sufficiently, sometimes, to cause their wilting. Hence, the transplanted seedlings may require artificial shading from the direct rays of the sun for from two to seven days or until they are out of danger from wilting. Wilting is more pronounced in the dry than in the wet season.

With a view to remedying the defect of the ordinary hand trowel in the transplanting of seedlings, the writer designed a transplanting tool in 1935.

DESCRIPTION OF THE TOOL

This tool (fig. 1) is conical-frustum-shaped and is made of tin or plain galvanized iron. A thin sheet of iron may also be used.

Three sizes have been designed. The first has bases of 1 1/8″ and 2″ diameters and a slant height of 4⅜″. Another one has bases of 1½″ and 2⅝″ diameters and a slant height of 6½″, and the third has bases of 2½″ and 3¾″ diameters and a slant height of 8¾″.

PROCEDURE IN USING THIS TOOL

When used, this implement is held vertically over the seedling to be transplanted with the smaller base pointing to the soil and the seedling in line with the center (fig. 2). As it is sunk into the soil, it is given a rotary motion, either clockwise or counterclockwise, to facilitate the cutting of the soil. When the desired depth is attained, the tool is twisted a bit and raised and the seedling is thus uprooted together with an undisturbed ball of earth adhering to the root system. If the nursery soil is dry and hard, it is first watered in order to facilitate digging up the seedling. When this transplanting tool is used, however, the seed boxes or the nursery beds must not be sown too thickly, otherwise many seedlings may be destroyed in transplanting.

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[1] Experiment Station contribution No. 1242. Read before the Los Baños Biological Club, October 28, 1937.

Next, the tool is inverted by holding it with either hand at the bigger base, and the seedling is allowed to protrude between the forefinger and the middle finger. By tapping the tool gently or by an upward and downward motion of both hands holding the transplanting tool, the seedling, together with the ball of earth adhering to its roots, is dislodged from the frustum.

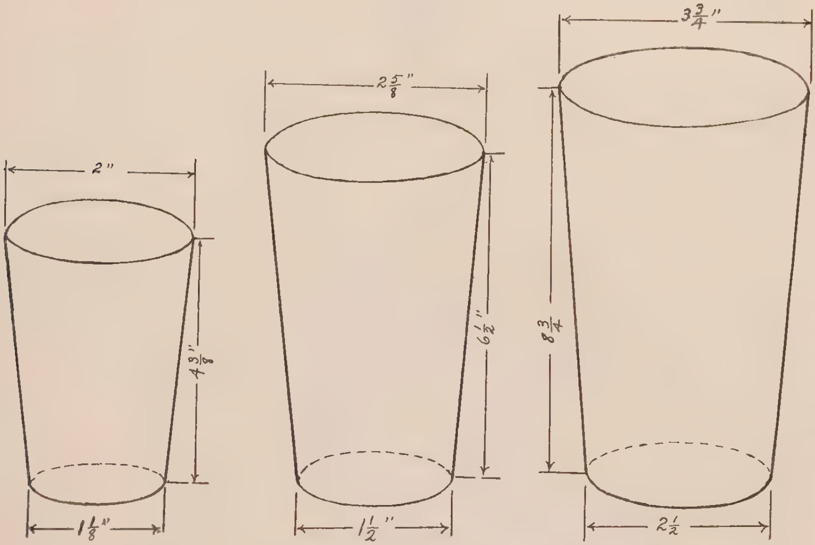

Fig. 1.—Sketches of the conical frustrum-shaped transplanting tool

The seedling is next lowered into a previously made hole slightly bigger than the one from which it has been removed. Transplanting is finished by lightly compacting the soil around the base of the newly transplanted seedling and, in the dry season, watering it.

OBSERVATIONS ON THE USE OF THIS NEW TRANSPLANTING TOOL

According to the observation of the writer, artificial shading is not needed, even during the dry season, after a seedling has been transplanted with the use of this new tool.

Table 1 gives some data gathered from experiments conducted in 1935 and in 1936 in Paniqui, Tarlac, in which the effect of the use of ordinary hand trowel in transplanting and that of this tool were compared. Four kinds of plants were used, namely, papaya (*Carica papaya* Linn.), eggplant (*Solanum melongena* Linn.), watermelon (*Citrullus vulgaris* Schrad.), and roselle (*Hibiscus subdariffa* Linn.).

Two cultures were tried, namely, the wet season and the dry season. The former was conducted in August, 1935, and the latter in February, 1936. The transplanted seedlings in the wet-season culture were neither watered nor provided with shade, while those transplanted in the dry-season culture were not provided with artificial shade but were watered uniformly in the morning and in the afternoon. In both cultures the soil in which the seedlings were grown and transplanted was sandy.

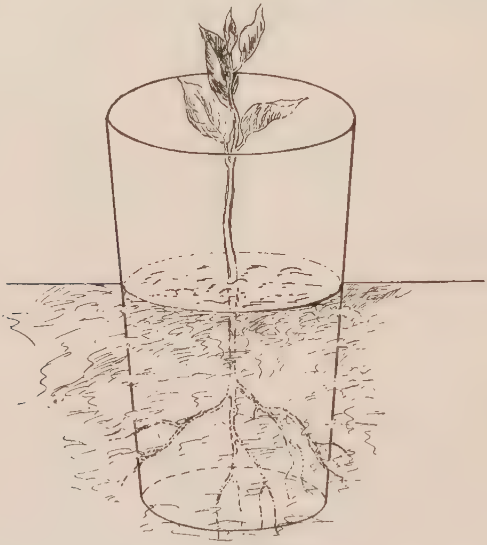

Fig. 2.—A diagrammatic sketch of the tool in use

It can be seen in table 1 that in transplanting with the conical frustum-shaped transplanting tool there was a very much lower percentage of mortality of the seedlings than with the trowel in both the wet and the dry-season cultures.

This tool has the following advantages:

1. The newly transplanted seedling requires no artificial shading even during the dry season.
2. The tool is cheaper to make than the hand trowel. An old piece of kerosene can may be used.
3. On the farm it is much more easily made than the trowel.

The writer believes that this tool will be very effective in transplanting seedlings of tobacco, sugar cane in cane breeding work, and most vegetable plants, provided the seedlings are not sown thickly in the seed boxes or nursery beds. This tool can be modified for use in transplanting forest tree seedlings, like pine, rubber tree, etc.

Within limits, any size of this tool can be made to suit the size of the seedling to be transplanted. As a rule, the larger the seedling, the larger should be the frustum of the tool that is used in transplanting it.

TABLE 1

Comparative mortality in transplanting seedlings

KINDS OF SEEDLINGS TRANSPLANTED	WET-SEASON CULTURE				DRY-SEASON CULTURE			
	Hand trowel		Transplanting tool		Hand trowel		Transplanting tool	
	seedlings used	mortality	seedlings used	mortality	seedlings used	mortality	seedlings used	mortality
	number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
Papaya	100	20	100	0	100	38	100	2
Eggplant ...	100	18	100	0	100	40	100	0
Watermelon .	100	25	100	1	100	60	100	3
Roselle	100	22	100	2	100	35	100	1

COLLEGE AND ALUMNI NOTES

The Los Baños Biological Club held its one hundred and thirty-first scientific meeting in the lecture hall of the Department of Agricultural Botany on June 30. Two papers were read:

> Mr. Emiliano F. Roldan. Mosaic disease of some crucifers. (Read by Mr. Roldan).
>
> Prof. Vicente B. Aragon and Mr. Esteban Cada. A preliminary report on the performance of ten varieties of Federated Malay States rices. (Read by Mr. Cada).

The Bailon-de la Rama Scholarship in Sugar Technology was awarded to Mr. Pedro R. Peralta, a freshman of this College, who obtained the highest rating in a competitive examination. This scholarship, which continues until the recipient's completion of his studies for the degree of Bachelor of Science in Sugar Technology, provides an allowance of ₱75 a semester for books and University fees and a monthly allowance of ₱27 for living expenses.

Preparations are under way for the celebration of the thirtieth anniversary of the founding of this College. Dr. N. B. Mendiola, head of the Department of Agronomy, has been appointed chairman of the Committee on Exposition by the Dean. Dr. F. M. Sacay, acting head of the Department of Agricultural Education, has been designated chairman of the Committee on a special issue of *The Philippine Agriculturist.*

Alumni who visited the College Campus recently:

Mr. Marcos de la Cruz, '29, junior agronomist of the Bureau of Plant Industry in Tuguegarao, Cagayan.

Mrs. Iluminada Torres-Mante, '34, teacher in Bilar Rural High School, Bohol.

Mr. Emilio Macasaet, '28. is starting a poultry farm in Lipa, Batangas, his home town, according to his letter to the Dean. He was formerly with the Goodyear Rubber Company who sent him to Sumatra and then placed him as field assistant on their estate in Kabasalan, Zamboanga. Recently, he was working for the Rio Grande Rubber Estate in Kabakan, Cotabato.

A STUDY OF VARIETAL CROSSES AND HYBRID VIGOR IN RICE[1]

J. M. CAPINPIN AND KRUI PUNYASINGH
Of the Department of Agronomy

WITH ONE TEXT FIGURE

Experiments on introduction and acclimatization of rice carried on in this College have shown that some of the Siamese rice varieties, particularly Nang Tani and Khao Bai Sri, are promising as regards yield, grade of clean rice, and eating quality. From the plant breeding standpoint, it is of value to determine the behavior of these varieties when crossed among themselves or with other economically important varieties. It seems that in hybridization work, the possibility of obtaining desirable combinations is materially enhanced by working with a relatively larger number of crosses; hence, these investigations were conducted.

Review of literature

Since these studies deal only with the characters manifested in the F_1, only investigations on agronomic and grain characters of first generation rice crosses will be briefly reviewed.

Hybrid vigor. Jones (1926) noticed marked evidence of hybrid vigor in the height of the rice plant, little evidence in the length of the panicles, and marked evidence in the number of the culms and yield per plant in the F_1, in comparison with the parental plants. Kadam, Patil, and Patankar (1937) reported that they found no hybird vigor in rice with respect to the height of plants, tillering, panicle length, and weight of the whole plant in the five crosses they made.

Flowering age. Van der Stok in 1910 (Ramiah, 1933a) found that earliness of the flowering age was entirely or almost entirely dominant over lateness in F_1 plants. Bhide (1926) found that lateness was dominant over earliness in the two varieties he crossed. Hoshino (1915) noticed that the flowering age of F_1 was intermediate between those of the two parents but inclined more toward that of the early parents. Ikeno (1918) and Ramiah (1933a) reported

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[1] Experiment Station contribution No. 1244.

THE PHILIPPINE AGRICULTURIST, VOL. XXVII, No. 4, SEPTEMBER, 1938.

that in crosses of early and late rice the F_1 was intermediate. Nomura and Yamasaki (1925) found that the F_1 hybrids were a few days later in flowering than the late parents. Jones (1928), after observing F_1 hybrids from various rice crosses, stated that F_1 plants might be earlier than the early parents or intermediate—that is, nearer to the early or to the late parents.

Awn character. Van der Stok, in 1910 (McKerral, 1913), crossed a variety with highly developed awn with an awnless one and obtained an awned F_1, but when a cross was made between a short awned variety and the awnless one, the F_1 plant was entirely without awn. Hoshino (1915), Kato in 1916 (Matsuura, 1929), and Lien Fang Chao (1928) reported that awnedness was dominant over awnlessness. Jones (1927) found the F_1 plants partly awned when he crossed awned with the awnless variety and further demonstrated (Jones, 1930) that a fully awned character was dominant over awnless and partly awned, and partly awned, over awnless.

Plant height. Ikeno (1927) observed that F_1 hybrids between two rice varieties were generally taller than the parents, and in one case, the height of F_1 plant was intermediate. Jones (1928) and Ramiah (1933b) found the F_1 plant to be taller than the average or either of the parents.

Color characters. Kato in 1916, (Matsuura, 1929) and Nagai (1921) reported purple awn was dominant over colorless awn. Lien Fang Chao (1928) found that in the F_1, colored apiculus and stigma were dominant over the colorless ones. Jones (1930) reported that all organs that were colored in either of the two parents, particularly the leaf sheath, paleas, leaf blade, awn, apiculi, lemma, internode, glume, stigma, node, ligule, auricle, and pulvini were found to be colored in the F_1 plants. Mitra and Ganguli (1937) crossed a variety bearing green palea with another bearing brown palea and found the F_1 to have green palea.

Grain characters. Van der Stok in 1910 (Matsuura, 1929), Lien Fang Chao (1928), Ramiah *et al* (1931), and Ramiah and Parthasarathi (1933) found the length of F_1 grain to be intermediate between those of the parents.

In the case of grain shattering, Kato in 1916 (Matsuura, 1929) found that non-shattering was dominant over shattering in F_1 plant, but Jones (1933) found it to be intermediate. On the other hand, Kadam (1936) crossed the wild rice which easily shatters with the non-shattering cultivated one and found the F_1 grains to shatter completely.

Objects of the study

The objects of the present study were: (*a*) to cross Siamese rices among themselves, with other introduced varieties, and with some native rice varieties; (*b*) to make comparative observations on the crosses of Siamese rice varieties produced; (*c*) to determine heterosis with regard to agronomic characters; and (*d*) to report new or interesting types that might arise in the F_1 population.

Time and place of the present work

These experiments were conducted in the plant breeding garden and laboratory of the Department of Agronomy, from May, 1936, to December, 1937.

MATERIALS AND METHODS

Varieties of rice used

All varieties of rice used in this experiment are lowland rices. They are briefly described as follows:

Khao Bai Sri. Siamese rice, introduced in 1919 (Borja, 1931), medium late variety, normally awnless, although occasionally with pale yellow awns measuring two to ten millimeters long. Vegetative parts, paleae, stigmata, apiculi, and short glumes, green. Grain, rather long (9.83 ± 0.014 mm.), non-shattering; hull, straw color; seed coat, white. Average yield in the Philippines, 59 cavans per hectare.

Nang Tani. Siamese rice, introduced in 1932, medium late variety, normally awnless, although occasionally with pale yellow awns, purple tinted towards their ends, two to five millimeters long. Vegetative organs green, except the purple base of the leaf sheath. Paleae and short glume, green; stigma and apiculi, purple. Grain, rather long (9.48 ± 0.015 mm.), non-shattering; hull, straw color; seed coat, white. Yield, 82 cavans per hectare in the College of Agriculture.[2]

Khao Ta Yam. Siamese rice, introduced in 1934, medium late variety, awnless. Vegetative and reproductive organs, green. Grain, medium long (8.76 ± 0.015 mm.), non-shattering; hull, straw color; seed coat, white. Yield, 60 cavans per hectare in Siam.[3]

Elon-Elon. Local variety, late maturing awnless. Vegetative and reproductive organs, green except dark olive green furrows of the paleae after anthesis. Grain, slender (8.11 ± 0.012 mm.), non-shattering; hull, straw color at base, slight brown towards the apex; seed coat, white. Yield, 65 cavans per hectare in the Philippines (Borja, 1931).

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[2] Information obtained from Prof. V. B. Aragon and Mr. E. Cada, of farm crops division.

[3] Information obtained from Mr. Panom, of Siam.

Macan China. Early maturing local variety, awnless. Vegetative parts, green, except purple base of the leaf sheath. Paleae and short glumes, green; stigma and apiculi, purple. Grain, short, 7.61 ± 0.010 millimeters long, non-shattering; hull, straw color; seed coat, white.

Macan Pulot. Local variety, early maturing and awnless. Vegetative and reproductive organs, green. Grain, long (8.80 ± 0.015 mm.), easily shatters; hull, straw color; seed coat, white.

Radin Siak 24. Malay rice, introduced in 1936, early maturing and awnless. Vegetative and reproductive organs, green. Grain, short, 7.61 ± 0.013 millimeters long, non-shattering; hull, straw color; seed coat, white. Yields 48 to 52 cavans per hectare in Malay.[2]

Reyong 20. Malay rice, introduced in 1936, early maturing, awnless. Vegetative and reproductive organs, green. Grain, medium length, 7.60 ± 0.010 millimeters long, non-shattering; hull, straw color with light brown towards apex; seed coat, white. Yields 75 cavans per hectare in Malay.[2]

Ramai. Saigon rice, introduced in 1919 (Borja, 1931), late maturing, awnless. Vegetative and reproductive organs, green. Grain, oblong, 8.36 ± 0.010 millimeters long, non-shattering; hull, straw color; seed coat, white. Yields 70 cavans per hectare in the Philippines.

Saigon Paaga 633A. Introduced into the College in 1935, medium late, awnless. Vegetative organs, green, reproductive organs, also green, except light brown furrows of paleae. Grain, medium size, 8.47 ± 0.012 millimeters long, non-shattering; hull, light brown; seed coat, white.

Crosses made

The following crosses were made and studied:

a. Khao Bai Sri × Khao Ta Yam
b. Nang Tani × Khao Bai Sri
c. Nang Tani × Macan Pulot
d. Nang Tani × Elon-Elon
e. Nang Tani × Saigon Paaga 633 A
f. Nang Tani × Radin Siak 24
g. Nang Tani × Reyong 20
h. Nang Tani × Macan China
i. Nang Tani × Ramai

In the above listed crosses, Siamese rices were used as either or both of the parents because there were few Siamese rice varieties available in the College.

Methods of investigations

Methods of planting. The grains of each variety were planted in petroleum cans filled with clay loam soil. In order to simulate lowland condition, the cans were prepared to retain water; that is, no holes were made in the bottoms. The seeds were planted in five hills in each can. Each variety was planted in four installments, five cans at a time and at ten-day intervals. The planting was so dated that the blooming period of all the varieties would coincide to facilitate varietal crossing.

Method of emasculation. As many flowers as possible of the female parents were emasculated at a time. The clip method of emasculation, which was found to be fast and efficient (Mulimbayan, 1935), was employed in these experiments. Emasculation was done from the top of the inflorescence downward so that pollen grains from the upper spikelets would not lodge on the lower ones. After emasculation, the panicles were covered with paper bags.

Pollination. In the following morning, at the time of dehiscence, the pollen grains were collected from the male parents into a Petri dish by tapping the inflorescence lightly. At the time of the natural opening, the bag was removed, and each spikelet was liberally supplied with pollen grains. All the pollinated panicles were then bagged again with light cellophane bags.

Germination of the crossbred grains

Before germination, the seeds were enclosed in an air-tight desiccator for about a month to be kept dry. The seeds were planted in artificial medium (Crone's solution), and not in ordinary soil, so that germination might not be impaired by harmful soil organisms. Both hybrid and parent grains were sown on January 27, 1937.

Culture of the first generation seed

The seeds of the hybrids and the parents were germinated on February 1, 1937. Both were transferred to small earthen pots filled with clay loam soil on February 5, 1937; and on March 18, 1937, they were transplanted to kerosene cans filled with clay loam soil at the rate of nine plants to each can. Because the planting (which was usually in August or September.) was out of season, two wire-screen cages were used to keep out the pests. During the flowering period, each plant was numbered according to its degree of earliness in flowering and number of the hybrids.

Field study of F_1 hybrid seedlings

Measurement of seedlings. Five days after germination, the height of the seedlings was measured with a foot ruler to determine the hybrid vigor of the F_1 seedlings in comparison with the parent seedlings.

Mature plant height at harvest was measured from the base of the plant to the basal node of the axis of panicle.

Age of flowering. By age of flowering is meant the time which elapsed from the date of the sowing of the rice up to the time of emergence of the first two or three spikelets from the last leaf sheath of the individual mother plant.

Measurement of panicle length. The panicle length was measured from the basal node of the panicle to the tip of the last grain of the same panicle, excluding the awn in the case of the semi-awned varieties.

Weight of panicle and grains per plant. In determining the yield, all panicles of one plant were weighed; then the grains were threshed and weighed on a Cenco balance.

Measurement of grain dimensions. A micrometer caliper was used in measuring the grains for length, longest diameter, or breadth, and shortest diameter, or thickness.

Other grain characters. During the development of the plant, all characters as regards anthocyan pigmentation of plant organs were closely noticed. The shattering character was measured on the basis of ease or difficulty in stripping with uniform force the grains of the mature panicles of the plant standing in the cans. Those that were hard to remove were considered non-shattering (Jones, 1933).

RESULTS AND DISCUSSION

The results of this study are presented in tables 1 to 12.

Percentage of setting

It may be noted in table 1 that the percentage of seed formed and seed that attained maturity varied greatly in the varietal crosses. The cross that had the highest percentage of setting was Nang Tani × Macan Pulot, and the cross that had the least percentage of setting was Nang Tani × Radin Siak 24. The variation in the percentage of setting may be due to the different degrees of compatibility in the different combinations of the varieties. In all crosses, the seeds that attained maturity were about one-half to three-fourths of the seeds set. The environmental effects, such as pests and diseases, may have contributed to low percentage of setting. It was noted that the seeds exposed through the clipped ends were often attacked by molds and worms.

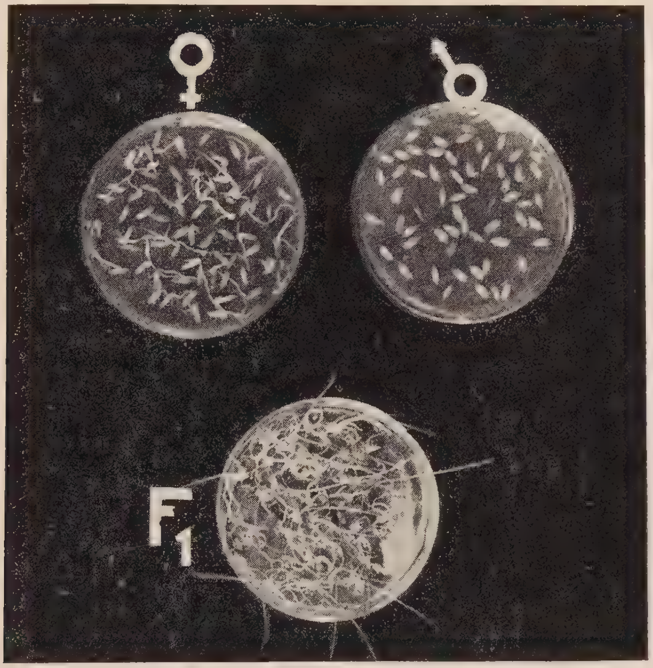

Fig. 1.—Photograph of parent and hybrid young seedlings, five days after sowing in Crone's germinating medium in Petri dishes; female parent Nang Tani, and male parent Ramai. × ⅓.

Percentage of germination

The germination of the crossbred grains (table 2) was lower than those of the parents, except crosses Nang Tani × Saigon Paaga 633A and Nang Tani × Ramai which had a higher percentage of germination than both parents. The low percentage of germination of the majority of the crossbred grains was perhaps due to the mechanical injury made on the endosperms of the grains following under-development after the flowers from which they were formed had been emasculated by the clip method. If this defect is considered, the germination of the crossbred grains was as high as the the parents in general.

Height of seedlings

The height of seedlings was measured five days after germination in Crone's solution (see fig. 1). As shown in table 3, seedlings of all F_1 crosses except Khao Bai Sri × Khao Ta Yam and Nang Tani × Macan Pulot were significantly higher than those of both parents. (Khao Bai Sri × Khao Ta Yam) F_1 and (Nang Tani × Macan Pulot) F_1 were insignificantly taller than the two parents. Among these groups, seedlings of (Nang Tani × Elon-Elon) F_1 were the most vigorous, while those of (Nang Tani × Reyong 20) F_1 were the least vigorous.

This indicated that there was heterosis in the seedling stage of the F_1 progeny in seven out of nine crosses of rice made. The uniformity of height of all F_1 hybrid seedlings was more marked than that of the parents, as indicated by the coefficient of variation.

Flowering age

The flowering age, or period of flowering, was the number of days which elapsed between the date of sowing and the date when the first two or three spikelets emerged from the last leaf sheath. In table 4 it is shown that (Khao Bai Sri × Khao Ta Yam) F_1 and (Nang Tani × Khao Bai Sri) F_1 were insignificantly and significantly earlier, respectively, in their flowering age than the early flowering parents. (Nang Tani × Macan Pulot) F_1 was intermediate between, but nearer to, the late parents. (Nang Tani × Saigon Paaga 633A) F_1 and (Nang Tani × Ramai) F_1 were intermediate between, but nearer to, the early parents. Crosses Nang Tani × Radin Siak 24, Nang Tani × Reyong 20, and Nang Tani × Macan China were all significantly later than their late parents, similar to that observed by Nomura and Yamasaki (1925). These results were the same as those reported by Jones (1928), which showed that F_1 plants from various crosses may be earlier than the early parents, later than the late parents, or nearer the early or late parents in the flowering age.

According to Ramiah (1933a), the flowering age is affected by the time of sowing. Sowings done earlier or later than the planting season result in either decreasing or increasing of the flowering age. It is also affected by spacing and soil fertility (Kadam et al, 1937), but when the parents are grown side by side and treated in the same way as the F_1 plants, the results are comparable. In the present experiment, it was found that the date of flowering of different rice varieties was, however, fairly constant. In general, the hybrids were more uniform in the flowering age than both or either one of the parents.

Plant height

As found by Ramiah (1933b), the height of rice plants is affected by the time of sowing. The variety that is sown early in the season has the longest period of development and hence, attains the maximum height. In this study, since the planting was done six months earlier than the planting season, the extraordinary height of the plants might thus be explained.

From the data given in table 5, it may be noted that (Khao Bai Sri × Khao Ta Yam) F_1, (Nang Tani × Macan Pulot) F_1 (Nang Tani × Elon-Elon) F_1, (Nang Tani × Reyong 20) F_1, and (Nang Tani × Ramai) F_1 plants were significantly taller than the taller parents, and that among this group, (Nang Tani × Elon-Elon) F_1 was the tallest. The crosses (Nang Tani × Khao Bai Sri) F_1, (Nang Tani × Saigon Paaga 633A) F_1, and (Nang Tani × Macan China) F_1 gave taller plants than the taller parents, but the difference was insignificant. The plant height of (Nang Tani × Radin Siak 24) F_1 was intermediate, between, but very much closer to, the tall parents.

Five of nine crosses made indicated heterosis in heights of plant, while the other four showed only the apparent dominance of tallness over shortness in the F_1 plants. These findings agree with that of Jones (1926), who found that F_1 crosses were taller than the taller parents.

Yield per plant

Weight of panicles per plant. As shown in table 6a, out of the nine crosses made, only two crosses showed marked increases in yield, as indicated by weight of panicle per plant over the parents. Those were (Nang Tani × Saigon Paaga 633A) F_1 and (Nang Tani × Macan China) F_1. The hybrids (Khao Bai Sri × Khao Ta Yam) F_1, (Nang Tani × Khao Bai Sri) F_1, (Nang Tani × Reyong 20) F_1, (Nang Tani × Elon-Elon) F_1, and (Nang Tani × Radin Siak 24) F_1 also showed an increase in yield over the parents, but it was insignificant. In the case of (Nang Tani × Macan Pulot) F_1 and (Nang Tani × Ramai) F_1, the yields were intermediate. In all cases, the weight of panicles per plant of the F_1 hybrid was more uniform than that of the parents, as shown by the coefficient of variation.

Weight of grain per plant. In table 6b, it is shown that two crosses (Nang Tani × Saigon Paaga 633A) F_1 and (Nang Tani × Macan China) F_1 showed marked increases in yield, as indicated by weight of grains per plant, over the two parents. The hybrids (Nang Tani × Khao Bai Sri) F_1, (Khao Bai Sri × Khao Ta Yam) F_1, (Nang Tani × Elon-Elon) F_1, (Nang Tani × Radin Siak 24) F_1, and (Nang Tani × Reyong 20) F_1 showed insignificant increase in yield over the parents. The yields of (Nang Tani × Macan Pulot) F_1 and (Nang Tani × Ramai) F_1 were intermediate between those of the two parents. In all cases, the weight of grain per plant of the hybrid was less variable than that of the parents, as shown by the coefficient of variation.

The weight of panicle and the weight of grain per plant, as observed in all above cases, follow the same trend.

Panicle length

The data presented in table 7 show that all the length of panicles of (Nang Tani × Khao Bai Sri) F_1, (Nang Tani × Saigon Paaga 633A) F_1, (Nang Tani × Reyong 20) F_1, (Nang Tani × Macan China) F_1, and (Nang Tani × Ramai) F_1 were significantly longer than their immediate parents. In the case of (Nang Tani × Radin Siak 24) F_1, the panicle length was slightly shorter than that of both parents.

In all cases, the panicle lengths of the F_1 plants were less variable than those of both parents or either of the two parents.

Karper and Quinby (1937), working on sorghum, explained hybrid vigor as the combination of dominant genes favorable to growth. This may be indicated morphologically in rice by the increase in height, yield, and panicle length. According to the present findings and those of many investigators, such as Jones (1926) and Kadam *et al* (1937), some F_1 plants showed an increase over the parents in height; others, an increase in yield and panicle length, and still others did not show the above changes at all.

Number of culms

As indicated in table 8, out of all crosses made, (Khao Bai Sri × Khao Ta Yam) F_1 was the only one that showed a significant increase in the number of culms. Kadam *et al* (1937) found one cross out of his five crosses which showed a significant increase in number of culms over the two parents, but the varieties used in this study were different from those used by Kadam *et al.* In all cases except (Nang Tani × Khao Bai Sri) F_1 and (Nang Tani × Ramai) F_1, the F_1 plants produced more uniform tillers than either of the two parents, as indicated by the coefficient of variation.

Grain measurements

Kikkawa (1912), Graham (1913), Beale (1927), Sethi and Saxena (1930), and Ramiah *et al* (1933) recognized that the material attributes of grains, namely, length, breadth, and thickness, are more constant than any other vegetative characters, and the size of the kernel inside the hull follows almost exactly the variation of the size of the unhulled grains with very few exceptions. On the other hand, Codd and Peterkin (1933) found that measurements of hulled grains are more consistent than those of unhulled grains. Unhulled grains were measured in this study.

Grain length. In table 9, all crosses were intermediate in grain length between the parents. The grain lengths of seven crosses were nearer to the longer-grained parents. Only the grains of two crosses, namely, (Khao Bai Sri × Khao Ta Yam) F_1 and (Nang Tani × Ramai) F_1, approached the shorter-grained parents. The foregoing results are similar to those obtained by Ramiah and Parthasarathi (1933), Lien Fang Chao (1928), and Van der Stok in 1910 (Matsuura, 1929).

Grain longest diameter, or breadth. As shown in table 10, (Khao Bai Sri × Khao Ta Yam) F_1, (Nang Tani × Saigon Paaga 633A) F_1, (Nang Tani × Macan China) F_1, and (Nang Tani × Ramai) F_1 were intermediate in breadth. In this group, (Khao Bai Sri × Khao Ta Yam) F_1 was nearer to the broader parent, while the rest approached the narrower parents. (Nang Tani × Elon-Elon) F_1 grains were broader than the two parents. (Nang Tani × Radin Siak 24) F_1 and (Nang Tani × Reyong 20) F_1 were the only crosses that produced narrower grains than both parents.

Grain shortest diameter, or thickness. As indicated in table 11, crosses (Nang Tani × Macan Pulot), (Nang Tani × Elon-Elon), (Nang Tani × Saigon Paaga 633A), and (Nang Tani × Macan China) showed markedly thicker grains than the parents. (Khao Bai Sri × Khao Ta Yam) F_1 and (Nang Tani × Khao Bai Sri) F_1 produced grains quite similar to those of the thicker-grained parents, while the grains of (Nang Tani × Reyong 20) F_1 and (Nang Tani × Ramai) F_1 resembled those of the thinner-grained parents. The grain of (Nang Tani × Radin Siak 24) F_1 was thinner than that of both parents. With one exception, the grain-thickness of all parent varieties did not vary much.

All grains of F_1 plants were more uniform in length, breadth, and thickness than the parent grains, as indicated by the coefficient of variation, but the length of the grains of each variety was least variable.

Inheritance of characters in F_1 progeny

As shown in table 12, the characters studied were color of seed coat, inner glume, apiculi, awn, and stigma, presence of awns, and shattering quality of the grains.

In all of the varieties used in this experiment, the seed coat of the grain was always white; F_1 plants of all crosses produced white-seed-coated grains. Saigon Paaga 633A had brown palea or inner glume furrows. When it was crossed with Nang Tani, which had green inner glume, the F_1 plant produced green inner glume. Although Parnell *et al* (1917) and Mitra *et al* (1937) used different rice varieties from those used by the writer, they obtained the same results. Nang Tani, which was used as the mother plant in most cases, had purple apiculus, stigma, awn, and leaf sheath. When crossed with a plant which is green in general, it produced F_1 plant which had the purple color in all the organs corresponding to the organs of Nang Tani. When Macan Pulot, a shattering variety, was crossed with non-shattering Nang Tani, the F_1 plant was non-shattering. This was also proved by Kato in 1916 in Japan (Matsuura, 1929). Kadam (1936), however, found that non-shattering was dominant in a cross between cultivated and wild rice.

The inheritance of awn character in F_1 hybrid was clearly shown in (Khao Bai Sri × Khao Ta Yam) F_1, which is partly awned. Khao Bai Sri, which was the mother plant, is partly awned, while Khao Ta Yam is awnless.

SUMMARY AND CONCLUSIONS

The present investigations deal with varietal crosses of rice with Siamese rice varieties used as either or both of the parents, and present data on heterosis based on these crosses. The following conclusions are drawn:

1. There was heterosis in the seedling stage of F_1 progeny of varietal crosses of rice on the basis of seedling length measured five days after sowing.

2. The flowering age of F_1 plants may be earlier than that of the early parents, as shown in cross (Nang Tani × Khao Bai Sri) F_1, later than that of the late parents, as shown in cross (Nang Tani

× Macan China) F_1, or intermediate, being nearer to the early, as in (Nang Tani × Ramai) F_1, or to the late parents, as in (Nang Tani × Macan Pulot) F_1.

3. Heterosis in the rice varieties used was marked in plant height, as shown in five out of nine crosses; in yield of grains, as indicated in two out of nine crosses; and in panicle length, as shown in five out of nine crosses; and not marked in the number of culms, as indicated in one out of nine crosses. There was no evidence of hybrid vigor in grain length and breadth, or longest diameter, but the grain thickness, or shortest diameter, showed little evidence of hybrid vigor.

4. Grain length and breadth of the F_1 plants were intermediate between those of the two immediate parents.

5. The F_1 population was more uniform in plant height, flowering age, yield, panicle length, number of culms, and grain length, breadth, and thickness than both parents, or either one of the parents in the majority of varietal crosses produced.

6. Among the characters studied of the unhulled grains, length, breadth, and thickness were most uniform, and among the grain dimensions, the grain length was the least variable.

7. In F_1 population, the following characters were observed: purple plant organs were dominant over the green or pale yellow organs; the green inner glume was dominant over the brown-furrowed inner glume; partly awned was dominant over awnlessness; and non-shattering was dominant over shattering character.

8. When the rice variety with white seed coat was crossed with one having identical characters of the seed, all the grains of the F_1 progeny possessed white seed coat.

9. The apparently promising F_1 types that were produced are (Nang Tani × Elon-Elon) F_1, which showed vigorous increase in height; (Nang Tani × Macan China) F_1, in yield; (Nang Tani × Reyong 20) F_1, in number of culms over the two parents.

10. The hybrids (Nang Tani × Saigon Paaga 633A) F_1, (Nang Tani × Ramai) F_1, and (Nang Tani × Macan China) F_1 showed promise with regard to yield in grains and number of culms per plant.

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TABLE 1

Some results of hybridization of different Siamese and other introduced rice varieties

CROSS NUMBER	PARENT VARIETIES		NUMBER OF TREATED FLOWERS	SEED FORMED		SEED MATURED	
	Female	Male		*Number*	*per cent*	*number*	*per cent*
1	Khao Bai Sri	Khao Ta Yam	1076	211	19.52	109	10.13
2	Nang Tani ..	Khao Bai Sri	1034	295	27.88	185	17.89
3	Nang Tani ..	Macan Pulot	860	314	36.51	182	21.16
4	Nang Tani ..	Elon-Elon	178	23	12.92	12	6.74
5	Nang Tani ..	Saigon Paaga 633A	664	87	13.10	62	9.34
6	Nang Tani ..	Radin Siak 24	393	25	6.36	16	4.07
7	Nang Tani ..	Reyong 20	447	40	8.95	35	7.83
8	Nang Tani ..	Macan China	1056	102	9.66	66	6.25
9	Nang Tani ..	Ramai	532	79	14.85	52	9.77

TABLE 2

Comparative germination of F_1 hybrids and their parents

PARENTS	NUMBER OF SEEDS		PERCENTAGE OF GERMINATION	F_1 HYBRIDS	NUMBER OF SEEDS		PERCENTAGE OF GERMINATION
	Planted	Germinated			Planted	Germinated	
Khao Bai Sri	50	44	88.0	(Khao Bai Sri × Khao Ta Yam) F_1	109	81	74.31
Nang Tani	50	45	90.0	(Nang Tani × Khao Bai Sri) F_1	185	154	83.24
Khao Ta Yam	50	48	96.0	(Nang Tani × Macan Pulot) F_1	182	90	49.45
Macan Pulot	50	41	82.0	(Nang Tani × Elon-Elon) F_1	12	10	83.33
Elon-Elon	50	46	92.0	(Nang Tani × Saigon Paaga 633A) F_1	62	60	96.77
Radin Siak 24	50	47	94.0	(Nang Tani × Radin Siak 24) F_1	16	14	87.50
Macan China	50	49	98.0	(Nang Tani × Reyong 20) F_1	35	31	88.57
Reyong 20	50	43	86.0	(Nang Tani × Macan China) F_1	66	48	72.73
Saigon Paaga 633A	50	40	80.0	(Nang Tani × Ramai) F_1	52	51	98.07
Ramai	50	48	96.0		—	—	—

TABLE 3

Comparative heights of seedlings of parents—F_1 hybrids, 5 days after germination in Crone's solution.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.	*cm.*	*per cent*
Khao Bai Sri	1.18 ± 0.09	0.61 ± 0.05	51.55 ± 3.94
Nang Tani	1.89 ± 0.18	0.96 ± 0.09	51.91 ± 6.51
Khao Ta Yam	2.02 ± 0.44	1.09 ± 0.11	53.91 ± 4.77
Macan Pulot	0.43 ± 0.38	0.25 ± 0.07	58.60 ± 16.14
Elon-Elon	1.30 ± 0.17	0.71 ± 0.11	54.62 ± 8.68
Saigon Paaga 633A	1.80 ± 0.25	1.13 ± 0.16	62.99 ± 8.85
Radin Siak 24	2.60 ± 0.12	1.06 ± 0.08	40.92 ± 3.09
Reyong 20	2.49 ± 0.15	1.32 ± 0.10	53.01 ± 4.10
Macan China	2.05 ± 0.57	0.90 ± 0.12	43.95 ± 5.81
Ramai		Germinating	
(Khao Bai Sri × Khao Ta Yam) F_1	3.32 ± 0.64	1.91 ± 0.14	53.23 ± 3.92
(Nang Tani × Khao Bai Sri) F_1	4.54 ± 0.61	2.07 ± 0.14	45.59 ± 2.96
(Nang Tani × Macan Pulot) F_1	2.87 ± 0.51	1.60 ± 0.11	55.75 ± 3.92
(Nang Tani × Elon-Elon) F_1	5.79 ± 0.56	2.49 ± 0.38	43.01 ± 6.49
(Nang Tani × Saigon Paaga 633A) F_1	5.39 ± 0.66	1.90 ± 0.15	35.25 ± 2.73
(Nang Tani × Radin Siak 24) F_1	5.10 ± 0.27	1.35 ± 0.18	26.47 ± 3.50
(Nang Tani × Reyong 20) F_1	3.85 ± 0.26	1.96 ± 0.18	50.91 ± 4.67
(Nang Tani × Macan China) F_1	4.67 ± 0.76	2.23 ± 0.68	47.75 ± 3.59
(Nang Tani × Ramai) F_1	4.49 ± 0.75	2.01 ± 0.16	44.77 ± 3.66

TABLE 4

Comparative flowering age of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	*days*	*per cent*
Khao Bai Sri	287.6 ± 0.7	2.1 ± 0.3	0.7 ± 0.1
Nang Tani	279.7 ± 0.5	4.0 ± 0.3	1.7 ± 0.3
Khao Ta Yam	276.4 ± 0.4	1.8 ± 0.3	0.7 ± 0.1
Macan Pulot	260.4 ± 0.8	3.5 ± 0.6	1.3 ± 0.2
Elon-Elon	290.1 ± 0.5	2.1 ± 0.4	0.8 ± 0.1
Saigon Paaga 633A	272.6 ± 0.6	2.5 ± 0.4	0.9 ± 0.2
Radin Siak 24	205.6 ± 0.9	4.0 ± 0.7	1.9 ± 0.3
Reyong 20	178.7 ± 0.6	2.8 ± 0.4	1.6 ± 0.2
Macan China	257.7 ± 0.7	3.2 ± 0.5	1.3 ± 0.2
Ramai	301.5 ± 0.3	1.4 ± 0.2	0.5 ± 0.1
(Khao Bai Sri × Khao Ta Yam) F_1	275.3 ± 0.2	1.9 ± 0.1	0.7 ± 0.1
(Nang Tani × Khao Bai Sri) F_1	275.8 ± 0.4	5.0 ± 0.3	1.7 ± 0.1
(Nang Tani × Macan Pulot) F_1	275.6 ± 0.5	2.8 ± 0.2	1.0 ± 0.1
(Nang Tani × Elon-Elon) F_1	277.0 ± 0.3	2.1 ± 0.3	0.9 ± 0.1
(Nang Tani × Saigon Paaga 633A) F_1	275.8 ± 0.6	4.8 ± 0.4	1.7 ± 0.1
(Nang Tani × Radin Siak 24) F_1	287.7 ± 0.6	2.9 ± 0.4	1.0 ± 0.1
(Nang Tani × Reyong 20) F_1	283.9 ± 0.6	3.4 ± 0.4	1.1 ± 0.1
(Nang Tani × Macan China) F_1	284.9 ± 0.6	4.7 ± 0.4	1.6 ± 0.1
(Nang Tani × Ramai) F_1	285.2 ± 0.4	4.3 ± 0.3	1.5 ± 0.1

TABLE 5

Comparative heights of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.	*cm.*	*per cent*
Khao Bai Sri	154.6 ± 1.8	7.9 ± 1.2	5.1 ± 0.8
Nang Tani	176.0 ± 3.1	19.6 ± 2.5	11.4 ± 1.1
Khao Ta Yam	153.0 ± 2.8	12.6 ± 2.0	8.2 ± 1.3
Macan Pulot	120.3 ± 1.4	6.3 ± 1.0	5.2 ± 1.0
Elon-Elon	149.7 ± 2.3	10.0 ± 1.6	6.7 ± 1.1
Saigon Paaga 633A	91.1 ± 1.5	6.7 ± 1.1	7.3 ± 0.1
Radin Siak 24	104.1 ± 1.7	7.4 ± 1.2	7.1 ± 1.1
Reyong 20	86.9 ± 1.7	7.6 ± 1.2	8.8 ± 0.1
Macan China	142.5 ± 1.3	5.8 ± 1.1	4.1 ± 0.6
Ramai	159.7 ± 2.1	9.2 ± 1.5	5.7 ± 1.1
(Khao Bai Sri × Khao Ta Yam) F_1	163.0 ± 1.0	10.5 ± 1.0	6.1 ± 0.3
(Nang Tani × Khao Bai Sri) F_1	179.1 ± 1.3	17.3 ± 1.0	9.7 ± 1.0
(Nang Tani × Macan Pulot) F_1	188.5 ± 1.4	15.6 ± 1.0	8.3 ± 1.0
(Nang Tani × Elon-Elon) F_1	198.6 ± 1.2	7.4 ± 1.2	3.7 ± 1.0
(Nang Tani × Saigon Paaga 633A) F_1	184.5 ± 1.5	16.0 ± 1.0	8.5 ± 1.0
(Nang Tani × Radin Siak) F_1	170.5 ± 1.5	7.1 ± 1.1	4.2 ± 1.0
(Nang Tani × Reyong 20) F_1	189.5 ± 2.2	16.7 ± 1.6	8.8 ± 1.0
(Nang Tani × Macan China) F_1	183.1 ± 1.5	12.5 ± 1.1	6.8 ± 1.0
(Nang Tani × Ramai) F_1	189.2 ± 1.0	8.3 ± 1.0	4.4 ± 0.3

TABLE 6a

Comparative average weights of panicles per plant of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	gm.	*gm.*	*per cent*
Khao Bai Sri	2.63 ± 0.17	0.17 ± 0.12	27.98 ± 3.66
Nang Tani	2.86 ± 0.21	0.98 ± 0.15	34.14 ± 6.78
Khao Ta Yam	2.52 ± 0.18	0.78 ± 0.13	31.07 ± 8.44
Macan Pulot	3.47 ± 0.25	1.09 ± 0.17	31.56 ± 8.67
Elon-Elon	2.63 ± 0.17	0.78 ± 0.12	29.42 ± 7.72
Saigon Paaga 633A	2.69 ± 0.15	0.64 ± 0.12	33.90 ± 5.60
Radin Siak 24	1.86 ± 0.15	0.66 ± 0.11	25.40 ± 6.10
Reyong 20	2.80 ± 0.12	0.55 ± 0.09	29.64 ± 4.34
Macan China	2.69 ± 0.28	1.23 ± 0.20	45.87 ± 9.66
Ramai	5.91 ± 0.38	1.67 ± 0.26	29.88 ± 7.91
(Khao Bai Sri × Khao Ta Yam) F_1	2.95 ± 0.08	0.96 ± 0.06	32.63 ± 2.22
(Nang Tani × Khao Bai Sri) F_1	3.27 ± 0.08	1.05 ± 0.06	32.25 ± 1.95
(Nang Tani × Macan Pulot) F_1	3.25 ± 0.08	0.88 ± 0.05	27.17 ± 2.03
(Nang Tani × Elon-Elon) F_1	3.30 ± 0.19	0.83 ± 0.13	25.18 ± 4.25
(Nang Tani × Saigon Paaga 633A) F_1	3.93 ± 0.16	1.51 ± 0.12	29.57 ± 3.46
(Nang Tani × Radin Siak 24) F_1	3.25 ± 0.19	0.91 ± 0.14	28.01 ± 3.20
(Nang Tani × Reyong 20) F_1	3.51 ± 0.13	0.96 ± 0.09	27.40 ± 4.13
(Nang Tani × Macan China) F_1	4.68 ± 0.25	2.05 ± 0.18	34.26 ± 5.80
(Nang Tani × Ramai) F_1	4.67 ± 0.24	2.24 ± 0.18	32.67 ± 5.00

TABLE 6b

Comparative average weight of grains per plant of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	gm.	*gm.*	*per cent*
Khao Bai Sri	2.30 ± 0.17	0.76 ± 0.12	33.13 ± 5.72
Nang Tani	2.75 ± 0.24	1.06 ± 0.17	38.47 ± 6.81
Khao Ta Yam	2.30 ± 0.18	0.80 ± 0.13	34.65 ± 6.11
Macan Pulot	3.25 ± 0.29	1.18 ± 0.20	36.32 ± 6.41
Elon-Elon	2.13 ± 0.14	0.61 ± 0.10	28.75 ± 4.81
Saigon Paaga 633A	2.63 ± 0.15	0.66 ± 0.11	24.94 ± 4.13
Radin Siak 24	1.75 ± 0.13	0.58 ± 0.09	33.07 ± 5.79
Reyong 20	2.03 ± 0.12	0.53 ± 0.08	26.36 ± 4.17
Macan China	2.53 ± 0.18	0.82 ± 0.13	32.28 ± 5.55
Ramai	5.86 ± 0.43	1.93 ± 0.31	32.93 ± 5.72
(Khao Bai Sri × Khao Ta Yam) F_1	2.75 ± 0.08	0.89 ± 0.05	32.55 ± 2.17
(Nang Tani × Khao Bai Sri) F_1	3.14 ± 0.08	1.04 ± 0.06	33.32 ± 2.22
(Nang Tani × Macan Pulot) F_1	3.11 ± 0.07	0.83 ± 0.05	26.70 ± 1.69
(Nang Tani × Elon-Elon) F_1	3.13 ± 0.21	0.92 ± 0.15	29.20 ± 4.97
(Nang Tani × Saigon Paaga 633A) F_1	3.87 ± 0.14	1.27 ± 0.10	32.98 ± 2.76
(Nang Tani × Radin Siak 24) F_1	3.00 ± 0.18	0.83 ± 0.13	27.68 ± 4.39
(Nang Tani × Reyong 20) F_1	3.27 ± 0.12	0.91 ± 0.09	27.64 ± 2.70
(Nang Tani × Macan China) F_1	4.63 ± 0.18	1.51 ± 0.13	32.63 ± 2.97
(Nang Tani × Ramai) F_1	4.27 ± 0.15	1.33 ± 0.11	31.07 ± 2.94

TABLE 7

Comparative panicle lengths of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.	*cm.*	*per cent*
Khao Bai Sri	20.33 ± 0.52	2.31 ± 0.37	11.36 ± 1.82
Nang Tani	23.23 ± 0.61	2.40 ± 0.42	12.01 ± 2.00
Khao Ta Yam	20.23 ± 0.50	2.23 ± 0.35	10.99 ± 1.61
Macan Pulot	24.67 ± 0.42	1.87 ± 0.30	7.59 ± 1.20
Elon-Elon	24.01 ± 0.41	1.83 ± 0.29	7.63 ± 1.21
Saigon Paaga 633A	22.67 ± 0.41	1.81 ± 0.29	7.99 ± 1.27
Radin Siak 24	23.23 ± 0.39	1.69 ± 0.27	7.25 ± 1.15
Reyong 20	23.23 ± 0.35	1.55 ± 0.25	6.67 ± 1.05
Macan China	25.00 ± 0.34	1.50 ± 0.24	6.00 ± 1.00
Ramai	23.12 ± 0.30	1.33 ± 0.21	5.77 ± 0.09
(Khao Bai Sri × Khao Ta Yam) F_1	20.60 ± 0.15	1.70 ± 0.10	8.25 ± 0.49
(Nang Tani × Khao Bai Sri) F_1	25.42 ± 0.20	2.53 ± 0.14	9.96 ± 0.54
(Nang Tani × Macan Pulot) F_1	25.63 ± 0.20	2.32 ± 0.14	9.04 ± 0.55
(Nang Tani × Elon-Elon) F_1	24.12 ± 0.44	1.93 ± 0.31	8.02 ± 1.27
(Nang Tani × Saigon Paaga 633A) F_1	25.59 ± 0.25	2.34 ± 0.19	9.14 ± 0.69
(Nang Tani × Radin Siak 24) F_1	23.05 ± 0.38	1.77 ± 0.27	7.69 ± 1.15
(Nang Tani × Reyong 20) F_1	29.61 ± 0.32	2.34 ± 0.22	7.92 ± 0.75
(Nang Tani × Ramai) F_1	26.20 ± 0.21	1.93 ± 0.15	7.38 ± 0.58
(Nang Tani × Macan China) F_1	27.81 ± 0.38	3.13 ± 0.27	11.23 ± 0.97

TABLE 8

Comparative number of culms of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.	*cm.*	*per cent*
Khao Bai Sri	1.00	0.00	0.00
Nang Tani	1.33 ± 0.09	0.47 ± 0.07	36.16 ± 6.24
Khao Ta Yam	1.22 ± 0.09	0.42 ± 0.06	34.04 ± 5.59
Macan Pulot	1.00	0.00	0.00
Elon-Elon	1.44 ± 0.11	0.48 ± 0.08	34.29 ± 4.28
Saigon Paaga 633A	1.44 ± 0.11	0.48 ± 0.08	34.29 ± 4.28
Radin Siak 24	1.89 ± 0.16	0.74 ± 0.12	39.02 ± 7.08
Reyong 20	1.67 ± 0.04	0.51 ± 0.03	32.60 ± 4.53
Macan China	1.66 ± 0.13	0.61 ± 0.09	39.10 ± 7.09
Ramai	2.11 ± 0.14	0.66 ± 0.09	31.24 ± 4.81
(Khao Bai Sri × Khao Ta Yam) F_1	1.98 ± 0.05	0.66 ± 0.03	33.72 ± 2.25
(Nang Tani × Khao Bai Sri) F_1	1.51 ± 0.04	0.55 ± 0.03	36.65 ± 2.26
(Nang Tani × Macan Pulot) F_1	1.38 ± 0.04	0.49 ± 0.03	35.29 ± 2.42
(Nang Tani × Elon-Elon) F_1	1.56 ± 0.11	0.50 ± 0.08	32.10 ± 2.55
(Nang Tani × Saigon Paaga 633A) F_1	1.59 ± 0.05	0.49 ± 0.03	30.96 ± 2.25
(Nang Tani × Radin Siak 24) F_1	2.00 ± 0.09	0.45 ± 0.06	32.35 ± 2.85
(Nang Tani × Reyong 20) F_1	1.12 ± 0.04	0.32 ± 0.03	28.93 ± 2.97
(Nang Tani × Macan China) F_1	1.18 ± 0.06	0.54 ± 0.04	29.61 ± 2.88
(Nang Tani × Ramai) F_1	1.75 ± 0.07	0.68 ± 0.05	38.97 ± 3.52

TABLE 9

Comparative lengths of unhulled grains of parents and F_1 hybrids.

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	mm.	*mm.*	*per cent*
Khao Bai Sri	9.83 ± 0.014	0.31 ± 0.010	3.19 ± 0.001
Nang Tani	9.48 ± 0.015	0.38 ± 0.010	3.45 ± 0.001
Khao Ta Yam	8.76 ± 0.015	0.32 ± 0.010	3.68 ± 0.001
Macan Pulot	8.80 ± 0.011	0.24 ± 0.008	2.78 ± 0.001
Elon-Elon	8.11 ± 0.012	0.25 ± 0.008	3.11 ± 0.001
Saigon Paaga 633A	9.47 ± 0.012	0.27 ± 0.009	3.20 ± 0.001
Radin Siak 24	7.61 ± 0.013	0.29 ± 0.009	3.81 ± 0.001
Reyong 20	7.60 ± 0.010	0.23 ± 0.007	2.99 ± 0.001
Macan China	7.61 ± 0.010	0.22 ± 0.007	2.90 ± 0.001
Ramai	8.36 ± 0.010	0.22 ± 0.007	2.67 ± 0.001
(Khao Bai Sri × Khao Ta Yam) F_1	9.23 ± 0.014	0.30 ± 0.010	3.27 ± 0.001
(Nang Tani × Khao Bai Sri) F_1	9.68 ± 0.016	0.34 ± 0.011	3.49 ± 0.001
(Nang Tani × Macan Pulot) F_1	9.42 ± 0.010	0.25 ± 0.009	2.74 ± 0.001
(Nang Tani × Elon-Elon) F_1	9.05 ± 0.014	0.29 ± 0.009	3.26 ± 0.001
(Nang Tani × Saigon Paaga 633A) F_1	9.26 ± 0.012	0.26 ± 0.008	2.78 ± 0.001
(Nang Tani × Radin Siak 24) F_1	8.98 ± 0.013	0.28 ± 0.009	3.15 ± 0.001
(Nang Tani × Reyong 20) F_1	9.06 ± 0.014	0.30 ± 0.009	3.27 ± 0.001
(Nang Tani × Macan China) F_1	9.14 ± 0.013	0.28 ± 0.009	3.11 ± 0.001
(Nang Tani × Ramai) F_1	8.87 ± 0.013	0.27 ± 0.009	3.09 ± 0.001

TABLE 10

Comparative longest diameters or breadth of unhulled grains of parents and F_1 hybrids

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	mm.	*mm.*	*per cent*
Khao Bai Sri	2.62 ± 0.003	0.08 ± 0.002	2.93 ± 0.001
Nang Tani	2.59 ± 0.005	0.11 ± 0.003	4.44 ± 0.001
Khao Ta Yam	2.59 ± 0.004	0.10 ± 0.003	3.68 ± 0.001
Macan Pulot	2.58 ± 0.004	0.08 ± 0.002	3.26 ± 0.001
Elon-Elon	2.52 ± 0.004	0.10 ± 0.003	3.92 ± 0.001
Saigon Paaga 633A	2.80 ± 0.009	0.15 ± 0.005	4.81 ± 0.001
Radin Siak 24	2.76 ± 0.006	0.13 ± 0.004	4.56 ± 0.001
Reyong 20	2.80 ± 0.005	0.11 ± 0.003	3.78 ± 0.001
Macan China	2.84 ± 0.006	0.10 ± 0.003	3.66 ± 0.001
Ramai	3.34 ± 0.006	0.13 ± 0.004	3.83 ± 0.001
(Khao Bai Sri × Khao Ta Yam) F_1	2.61 ± 0.004	0.09 ± 0.003	3.57 ± 0.001
(Nang Tani × Khao Bai Sri) F_1	2.69 ± 0.005	0.11 ± 0.003	4.10 ± 0.001
(Nang Tani × Macan Pulot) F_1	2.66 ± 0.005	0.11 ± 0.003	4.10 ± 0.001
(Nang Tani × Elon-Elon) F_1	2.67 ± 0.005	0.11 ± 0.003	4.29 ± 0.001
(Nang Tani × Saigon Paaga 633A) F_1	2.69 ± 0.005	0.11 ± 0.003	4.17 ± 0.001
(Nang Tani × Radin Siak 24) F_1	2.53 ± 0.003	0.07 ± 0.002	2.98 ± 0.001
(Nang Tani × Reyong 20) F_1	2.53 ± 0.003	0.07 ± 0.002	2.88 ± 0.001
(Nang Tani × Macan China) F_1	2.62 ± 0.004	0.10 ± 0.003	3.78 ± 0.001
(Nang Tani × Ramai) F_1	2.63 ± 0.002	0.06 ± 0.002	2.29 ± 0.001

TABLE 11

Comparative shortest diameter or thickness of unhulled grains of parents and F_1 hybrids

PARENTS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	mm.	*mm.*	*per cent*
Khao Bai Sri	1.96 ± 0.003	0.07 ± 0.002	3.37 ± 0.001
Nang Tani	1.85 ± 0.004	0.08 ± 0.002	4.53 ± 0.001
Khao Ta Yam	1.93 ± 0.003	0.07 ± 0.002	3.63 ± 0.001
Macan Pulot	1.88 ± 0.003	0.07 ± 0.002	3.57 ± 0.001
Elon-Elon	1.83 ± 0.002	0.06 ± 0.002	3.27 ± 0.001
Saigon Paaga 633A	1.87 ± 0.003	0.11 ± 0.002	5.23 ± 0.001
Radin Siak 24	1.88 ± 0.004	0.09 ± 0.002	4.53 ± 0.001
Reyong 20	1.92 ± 0.003	0.07 ± 0.002	3.90 ± 0.001
Macan China	1.80 ± 0.003	0.08 ± 0.002	4.62 ± 0.001
Ramai	2.21 ± 0.005	0.11 ± 0.003	5.07 ± 0.001
(Khao Bai Sri × Khao Ta Yam) F_1	1.97 ± 0.003	0.07 ± 0.002	3.35 ± 0.001
(Nang Tani × Khao Bai Sri) F_1	1.96 ± 0.004	0.09 ± 0.002	4.42 ± 0.001
(Nang Tani × Macan Pulot) F_1	1.92 ± 0.003	0.07 ± 0.002	3.71 ± 0.001
(Nang Tani × Elon-Elon) F_1	1.93 ± 0.003	0.07 ± 0.002	3.86 ± 0.001
(Nang Tani × Saigon Paaga 633A) F_1	1.91 ± 0.003	0.07 ± 0.002	3.76 ± 0.001
(Nang Tani × Radin Siak 24) F_1	1.78 ± 0.003	0.08 ± 0.002	4.30 ± 0.001
(Nang Tani × Reyong 20) F_1	1.85 ± 0.003	0.07 ± 0.002	3.80 ± 0.001
(Nang Tani × Macan China) F_1	1.91 ± 0.003	0.07 ± 0.002	3.61 ± 0.001
(Nang Tani × Ramai) F_1	1.86 ± 0.003	0.06 ± 0.002	3.43 ± 0.001

TABLE 12

Inheritance of characters in rice crosses

CHARACTERS STUDIED	CHARACTERS DOMINANT IN F_1	CROSSES SHOWING THE DOMINANT TRAIT
Seedcoat color:		
white × white	white	All crosses
Inner glume color:		
green × brown furrow	green	Nang Tani × Saigon Paaga 633A
Inner glume apex and apiculi color:		
purple × greenish	purple	All crosses except: Nang Tani × Macan China Khao Bai Sri × Khao Ta Yam
Awn color:		
purple × colorless	purple	Nang Tani × Khao Bai Sri
Stigma color:		
purple × greenish	purple	All crosses except: Nang Tani × Macan China Khao Bai Sri × Khao Ta Yam
Leaf sheath color:		
purple × green	purple	All crosses except: Nang Tani × Macan Pulot Khao Bai Sri × Khao Ta Yam
Presence of awns:		
partly awned × awnless	partly awned	Khao Bai Sri × Khao Ta Yam
Shattering character:		
non-shattering × shattering	Non-shattering	Nang Tani × Macan Pulot

THE EFFECTS OF RATIONS CONTAINING DIFFERENT AMOUNTS OF SHRIMP MEAL ON THE EGG PRODUCTION OF DUCKS[1]

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In a paper published recently (Fronda and Mencias, 1937), it was reported that the best amount of protein supplement in the ration for production of the largest number of eggs in ducks is 30 per cent fish meal. Cruz (1932), using shrimp meal as supplement to a mash containing 60 parts, by weight, of rice bran and 20 parts of corn meal in the amount of 20 per cent of the ration, reported an average production of 225.35 eggs a year. Is the amount of shrimp meal used by Cruz not the optimum for the most economical production of eggs? An answer to this question will be most timely at present and may stimulate the duck industry which is now very dependent on snails, the supply of which is unreliable.

This study was conducted in the Department of Animal Husbandry. The experiment was begun on June 14, 1935, and ended on June 13, 1936.

PLAN OF THE STUDY

Four lots, each consisting of thirty-five laying ducks and three drakes, were used. The care, housing, methods of feeding, and other conditions were practically the same in all lots; the only variable environmental factor was the kind of ration given to each lot.

The rations given to the different lots were as follows:

LOTS	SHRIMP MEAL	FISH MEAL	CORN MEAL	RICE BRAN	TOTAL	NUTRITIVE RATIO [a]
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	
I	—	30.0	17.5	52.5	100.0	1:2.1
II	20.0	—	20.0	60.0	100.0	1:3.1
III	30.0	—	17.5	52.5	100.0	1:2.3
IV	40.0	—	15.0	45.0	100.0	1:1.7

[a] Based on the chemical analysis of the feeds

To every 100 kilograms of the mash mixture was added one kilogram of common table salt. From August 23, 1935, when the yards became barren, chopped green grass was given to each lot morning and afternoon. From November 23, 1936, when it was noticed that the shells of the eggs produced were thinner than the normal, two kilograms of shell were added to every 100 kilograms of the mash mixture.

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[1] Experiment Station contribution No. 1245.

The birds were fed four times a day; twice in the morning, at about six and ten o'clock, and twice in the afternoon, at two and four o'clock. The feed was given wet in galvanized iron feeding troughs. The ducks were given as much feed as they were able to consume. Drinking water, changed four or five times a day, was accessible to the birds at all times. The feeding and drinking troughs were cleaned thoroughly every afternoon when the ducks had already been confined in the laying house for the night.

The birds were housed in similar pens about 3.5 meters wide and 3.5 meters long. Each pen was provided with a yard measuring about 3.5 meters by 13 meters. A cogon shed was provided in each. The yards were separated from each other by a chicken wire fence which was 56 centimeters high. This made it possible for the caretaker to go over the fences from pen to pen. The birds were driven into the house in the evening and released into the yards in the morning.

Records kept. The eggs were collected every morning and weighed individually. The amount of feed consumed was noted and recorded. The mortality in the different pens was also recorded.

RESULTS AND DISCUSSION

Egg production. The results obtained in this study show that the highest average egg production was obtained in lot IV (40 per cent shrimp meal), 51.6 per cent; lot I (30 per cent fish meal) was second, 50.4 per cent; lot III (30 per cent shrimp meal), third, 46.4 per cent; and lot II (20 per cent shrimp meal), the lowest, 43.7 per cent. Expressed in terms of eggs, the average egg production of each lot was: lot IV, 189.7 eggs; lot I, 184.0 eggs; lot III, 168.9 eggs; and lot II, 159.2 eggs (see table 1).

Feed consumption. From the records of feed consumption, it was determined that lot I (30 per cent fish meal) consumed during the year an average of 50.1 kgm. of feed per birds; lot II (20 per cent shrimp meal), 47.4 kgm.; lot III (30 per cent shrimp meal), 48.1 kgm.; and lot IV (40 per cent shrimp meal), 48.5 kgm. It may be seen from these figures that all the rations tested were equally palatable although the ration containing 30 per cent fish meal was probably slightly more palatable than the others. The average feed consumption of lot II compares very favorably with that reported by Cruz (1932), which was 46.6 kgm. per bird per year.

Based on the prices of feeds in the Department of Animal Husbandry at the time of the experiment, it cost to feed each laying duck a year as follows: lot I (30 per cent fish meal), ₱2.88; lot II (20 per cent shrimp meal), ₱2.99; lot III (30 per cent shrimp meal), ₱3.72; and lot IV (40 per cent shrimp meal), ₱4.43. The cost of feed of all the shrimp meal lots was higher than the check lot, lot I (30 per cent fish meal), because of the higher price of shrimp meal, which cost ₱17.57 per 100 kgm. while fish meal cost only ₱11.00 per 100 kgm.

Amount of feed required to produce one dozen eggs. The amount of feed needed to produce one dozen eggs was obtained by dividing the total amount of feed consumed by the total number of eggs produced by the lot and multiplying the quotient by 12. From the figures obtained, lot II (20 per cent shrimp meal) required the greatest amount of feed to produce one dozen eggs, 3.9 kgm., and lot IV (40 per cent shrimp meal) needed the least, 3.4 kgm. Lot III (30 per cent shrimp meal) required 3.7 kgm. and lot I (30 per cent fish meal), 3.6 kgm.

The cost of feed needed to produce one dozen eggs varied in the different lots. Lot IV (40 per cent shrimp meal) produced the most expensive eggs, 30.6 centavos per dozen, and lot I (30 per cent fish meal), the most economical, 20.6 centavos per dozen. The cost of feed needed to produce one dozen eggs in lot II (20 per cent shrimp meal) was found to be 24.6 centavos, and that in lot III (30 per cent shrimp meal), 28.9 centavos. Thus, it will be seen that although lot IV (40 per cent shrimp meal) needed the least amount of feed to produce a dozen eggs, the cost of the feed needed to produce a dozen eggs was the highest, the ration given to this lot being the most expensive.

Efficiency of the rations studied. A comparison of the relative efficiencies of the different rations studied expressed in percentage is shown in table 2. With the figures obtained in lot I (30 per cent fish meal) as 100 per cent, it will be seen in table 2 that the average efficiency of the different rations based on the number of eggs produced and on the amount and cost of feed required to produce one dozen eggs, lot IV (40 per cent shrimp meal) was second to lot I, with 87.1 per cent; lot II (20 per cent shrimp meal), third, with 86.3 per cent; and lot III (30 per cent shrimp meal), the least efficient, with only 82.9 per cent. Lot IV, producing the greatest number of eggs, needed the least amount of feed to produce them per dozen, but the cost of this feed was the highest of all the rations studied. From these figures, it may be stated that lot I (30 per cent fish meal) received the most efficient ration. Of the shrimp meal lots, lots II (20 per cent shrimp meal) and IV (40 per cent shrimp meal) are about the same in average efficiency and lot III (30 per cent shrimp meal), the least.

Effects of the different rations on the birds. In general, the different rations studied did not produce any unfavorable effect upon the birds. It was observed that mortality in all lots was highest in the month of May. During this month the days were hot. The mortality in August was also high; this may be due to strong winds, heavy rains, and sudden and abrupt changes in temperature from hot to cold and vice versa. These unfavorable conditions may have depressed the birds and made them more susceptible to diseases.

It was observed also that the percentage of mortality during the whole period of the experiment was lowest in lot II (20 per cent shrimp meal), with a mortality of only 13.2 per cent. The mortality in lot I (30 per cent fish meal) was highest, 26.3 per cent; that of lot III (30 per cent shrimp meal) was next, with 23.7 per cent, and that of lot IV (40 per cent shrimp meal) was third, 21.1 per cent. While there are no significant differences between the mortality in these three lots, the differences between these and that of lot II is significant. These results tend to show that a supplement of 30 per cent or more of either fish meal or shrimp meal in the ration increased the mortality.

Returns above feed cost. The figures given in table 3 are based on a flock of 100 layers. It may be seen in this table that the biggest return above feed cost was obtained from lot I (30 per cent fish meal) and the least, from lot IV (40 per cent shrimp meal). Of the shrimp meal lots, lot II (20 per cent shrimp meal) gave the biggest return above the cost of feed, ₱155.29. As the amount of shrimp meal in the ration was increased, the returns above feed cost decreased.

It may be seen in table 3 that lot IV (40 per cent shrimp meal) produced the biggest total number of eggs and lot II (20 per cent shrimp meal), the second. Lot I (30 per cent fish meal) ranks only third in egg production, but because the cost of the ration was lowest in this lot, the return above feed cost was the highest. The cost of the feed consumed was highest in lot IV, so that in spite of the fact that this lot brought in the biggest income from the sale of eggs, the return above the cost of feed from this lot was the lowest. These figures again show that the best lot was lot I (30 per cent fish meal) and the second, lot II (20 per cent shrimp meal).

SUMMARY AND CONCLUSIONS

1. On the basis of the average annual egg production, the different rations tested ranked as follows: lot IV (40 per cent shrimp meal), first; lot I (30 per cent fish meal), second; lot III (30 per cent shrimp meal), third; and lot II (20 per cent shrimp meal), last.
2. The rations tested were equally palatable, although the ration containing 30 per cent fish meal appeared to be slightly more palatable than the others.
3. Lot II (20 per cent shrimp meal) required the greatest amount of feed to produce one dozen eggs and lot IV (40 per cent shrimp meal), the least.
4. The most expensive eggs were produced in lot IV (40 per cent shrimp meal), and the most economical eggs, in lot I (30 per cent fish meal).
5. On the basis of average efficiency based on the number of eggs produced and on the amount and cost of feed needed to produce a dozen eggs, the different lots ranked as follows: lot I (30 per cent fish meal), first; lot IV (40 per cent shrimp meal), second; lot II (20 per cent shrimp meal), third; and lot III (30 per cent shrimp meal), the least efficient.
6. The percentage of mortality during the whole period of the experiment was lowest in lot II (20 per cent shrimp meal) and highest in lot I (30 per cent fish meal).
7. Based on a flock of 100 layers and on actual figures obtained in this study, lot I (30 per cent fish meal) brought in the biggest return from the sale of eggs above the cost of feed; lot II (20 per cent shrimp meal), second; lot III (30 per cent shrimp meal), third; and lot IV (40 per cent shrimp meal), the least.

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FRONDA, F. M., AND LEON L. MENCIAS. 1937. The use of fish meal in duck rations for egg production. The Philippine Agriculturist **26**: 290–294.

TABLE 1

Percentage egg production of each lot

PERIODS	LOT I 30% FISH MEAL	LOT II 20% SHRIMP MEAL	LOT III 30% SHRIMP MEAL	LOT IV 40% SHRIMP MEAL
1935	*per cent*	*per cent*	*per cent*	*per cent*
June 14—July 13	53.7	42.0	40.4	48.2
July 14—Aug. 13	52.0	36.1	44.7	58.5
Aug. 14—Sept. 13	25.9	28.4	30.3	48.5
Sept. 14—Oct. 13	29.6	27.6	38.3	38.7
Oct. 14—Nov. 13	58.4	42.1	41.0	58.4
Nov. 14—Dec. 13	64.6	52.7	48.8	55.6
Dec. 14—Jan. 13	50.4	49.7	45.7	50.4
1936				
Jan. 14—Feb. 13	63.8	58.8	49.1	64.0
Feb. 14—March 13	72.4	60.5	62.6	63.0
March 14—April 13	51.5	58.4	71.0	53.5
April 14—May 13	43.7	40.5	55.2	47.7
May 14—June 13	39.2	27.1	29.4	32.8
Average	50.4	43.7	46.4	51.6

TABLE 2

Comparison of the relative efficiencies of the different rations tested

LOT NO.	PROTEIN SUPPLEMENT	AVERAGE NUMBER OF EGGS	AMOUNT OF FEED TO PRODUCE ONE DOZEN EGGS	COST OF FEED TO PRODUCE ONE DOZEN EGGS	AVERAGE
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
I	30 fish meal	100.0	100.0	100.0	100.0
II	20 shrimp meal	86.5	91.7	80.6	86.3
III	30 " "	91.8	97.2	59.7	82.9
IV	40 " "	104.1	105.6	51.5	87.1

TABLE 3

Returns above feed cost from a flock of 100 layers

LOT NO.	SUPPLEMENT	AVERAGE NO. OF BIRDS AT END OF YEAR [a]	TOTAL NUMBER OF EGGS	VALUE OF EGGS [b]	TOTAL AMOUNT OF FEED	COST OF FEED [c]	RETURNS ABOVE COST OF FEED
	per cent			*pesos*	*kgm.*	*pesos*	*pesos*
I	30 fish meal	74	13,616	408.48	3707.4	213.18	195.30
II	20 shrimp meal	87	13,850	415.50	4123.8	260.21	155.29
III	30 " "	76	12,836	385.08	3655.6	282.21	102.87
IV	40 " "	79	14,986	449.58	3831.5	349.82	99.76

[a] Based on actual mortality figures

[b] At ₱3.00 a hundred

[c] The costs of the rations per 100 kgm. were: lot I, ₱5.75; lot II, ₱6.31; lot III, ₱7.72; and lot IV, ₱9.13

SHOULD SUPERPHOSPHATE BE ADDED WITH AMMONIUM SULFATE TO LIPA CLAY LOAM FOR UPLAND RICE?[1]

BENIGNO G. TALAMISAN

WITH SEVEN TEXT FIGURES

Low yield might in no small measure be responsible for the fact that upland rice is not generally raised on a commercial scale in the Islands. One way of increasing the yield would obviously be by a judicious use of fertilizers. Hence, this study was made to determine if superphosphate should be added with ammonium sulfate to our common upland rice soil, Lipa clay loam, to produce good growth and a high yield of this plant.

Review of literature

Available literature shows that application of ammonium sulfate to Lipa clay loam brought about good growth and increase in the yield of upland rice plants. Almeda (1937) found, among other things, that as the rice plants grew older and as they received more ammonium sulfate fertilizers, more dry matter was produced. The percentage of ash from tops, however, decreased with the age of the plant and with the amount of ammonium sulfate used. Like Soriano (1934), Almeda (1937) noted that the intensity of the green color of the leaves was increased as the amount of the fertilizers was increased. Soriano (1934) determined the chlorophyll content of the leaves and found that it increased with the amount of sulfate of ammonia employed.

At Biggs Rice Station, California, Jones (1931) found that 150 pounds of sulfate of ammonia per acre (168.47 kgm. per hectare) gave the most profitable yield. In China, Chan (1929) reported that an application of 200 pounds per acre (224.61 kgm. per hectare) gave the highest yield of rice. He noted, however, that the increases in yield were not proportional to those of the fertilizer used. Reynolds and Wyche (1929) reported similar findings. They observed in Texas that 100 pounds of ammonium sulfate to the acre (112.31 kgm. per hectare) produced rice grain most profitably, although the yields of rice increased with the application of the fertilizer; nevertheless, the rate of increase was not proportional to the amount of fertilizer used.

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[1] Experiment Station contribution No. 1246. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

Phosphatic fertilizer has also produced certain effects on rice. In Pennsylvania State College, Noll (1923) found that phosphatic fertilizers induced earlier ripening of the grain crops like corn, wheat, oats, etc., on soils low in phosphorus. In dry years, however, it was observed that phosphates caused premature ripening and a decrease in yield. It was further observed that increasing the rate of application of the phosphatic fertilizers above the need of the crop failed to hasten ripening of the grains.

Macasaet (1936) computed the N-P_2O_5-K_2O contents of the culture medium that gave the best growth and the highest yield of an upland rice and found that the medium contained 27.6 grams N, 91.2 grams P_2O_5, and 95.0 grams K_2O.

Objects of this study

The objects of this study were: (*a*) to determine whether Lipa clay loam lacks phosphate if planted to upland rice; (*b*) to determine if superphosphate should be added with ammonium sulfate to Lipa clay loam to produce good growth and high yield of upland rice; and (*c*) to determine if addition of superphosphate with relatively large amounts of ammonium sulfate to Lipa clay loam would counteract the harmful effects of the latter fertilizer on the yield of the plant.

Time and place of this study

The culture part of this study was conducted in the experimental yard of the Department of Agricultural Botany from July 18, 1937, to December 5, of the same year.

MATERIALS AND METHODS

The plant

In this study an upland rice plant, variety Inintiw, was used. The seeds were obtained from the Department of Agronomy, College of Agriculture. They were soaked overnight in water and planted six to a pot. When the seedlings were one week old, some of them were pulled up, and only two apparently uniformly developed healthy plants were left in each pot.

The soil

Lipa clay loam taken from a lot near the U. P. Rural High School reservation was used. It was thoroughly pulverized, sifted, and mixed. About nineteen kilograms were placed in each pot. Samples of the soil were analyzed in the Department of Agricultural Chemistry, and the results showed that it contained 0.13 per cent N, 0.20 per cent P_2O_5, and 0.19 per cent K_2O. Tin cans, 23.5 centimeters by 23.5 centimeters and 35 centimeters high were used as containers.

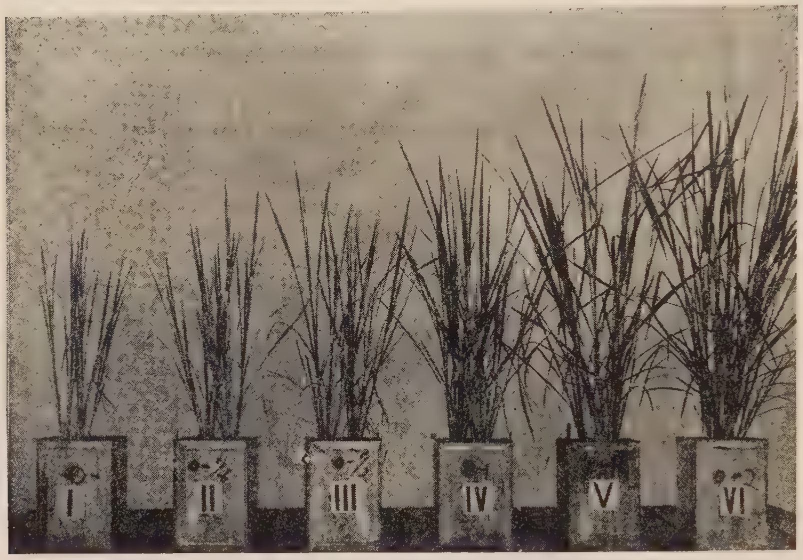

Fig. 1.—Rice plants at booting stage grown in Lipa clay loam supplied with ammonium sulfate. Cultures I (control), no fertilizer; II, 1.38 grams; III, 2.75 grams; IV, 5.5 grams; V, 8.25 grams; VI, 11.0 grams of ammonium sulfate. (Experiment from July 18, 1937, to October 31, 1937).

The fertilizers used

Single fertilizers. Single superphosphate containing 18 to 20 per cent of P_2O_5 and ammonium sulfate containing 20.6 per cent N were used. After the seeds had been planted in the pots, these fertilizers were separately applied to the soil. The superphosphate was added at the rate of ¼, ½, 1, 1½, 2, and 2½ tons per hectare; and the ammonium sulfate, at the rate of ¼, ½, 1, 1½, and 2 tons per hectare. The exact amount of ammonium sulfate used per pot in each culture was as follows: in culture II, 1.38 grams; III, 2.75

grams; IV, 5.5 grams; V, 8.25 grams; and VI, 11.0 grams, (see tables 1 and 2). The exact amount of superphosphate applied per culture is as shown in tables 3 and 4. Each of the cultures supplied with ammonium sulfate was run in triplicate, whereas each of the superphosphate-fertilized cultures was conducted in quadruplicate.

Fertilizer mixtures. Ammonium sulfate and superphosphate were applied to the cultures in different amounts. For instance, to 1.38 grams of ammonium sulfate per culture were added separately different amounts of superphosphate. Likewise, to 2.75 grams of ammonium sulfate were added separately different amounts of superphosphate. This plan of mixing the two fertilizers was continued so that 5.50, 8.25, and 11.00 grams of ammonium sulfate were separately mixed with different amounts of superphosphate, as shown in table 5. In this table, culture I was the control; it received no fertilizer. The other cultures, from II to XXVI received the two fertilizers, ammonium sulfate and superphosphate, in different combinations, but no two mixtures were exactly alike.

EXPERIMENTS AND RESULTS

Sets of cultures and data obtained

Two series of fertilizer cultures with upland rice were conducted. The first was started on July 18, 1937, and was composed of three sets of cultures. The first set consisted of six cultures supplied with varying amounts of ammonium sulfate. The second contained seven cultures with varying amounts of superphosphate. The third consisted of twenty-six cultures supplied with mixtures of ammonium sulfate and superphosphate of different proportions. Each set was run in triplicate and each included three unfertilized cultures, as control. At the booting stage of the plants, the cultures in the different sets were photographed (see fig. 1 for first set, fig. 2 for second set, and fig. 3a to 3e for third set). On October 31, 1937, that is, at maturity of the plants, the cultures were harvested and experimental data [2] were gathered as directed under *Criteria of results.*

The second series of cultures, which was a repetition of the first, was started on August 28, 1937, and harvested on December 5, 1937. The mass of experimental data [2] was gathered also as directed.

It should be noted that the two series of comparative fertilizer pot culture tests with upland rice were conducted during the time usually most appropriate for rice culture in Los Baños. Consequently, when grown in suitable culture media, the rice plants attained full development, and the poor stands of the plants in some of the culture may be attributed, not to unfavorable climate, but to the unsuitable or unbalanced culture media employed (see fig. 1, 2, and 3a to 3e).

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[2] The mass of experimental data is on file in the Department of Agricultural Botany.

Criteria of results

The criteria of results herein used are: (*a*) number of tillers, (*b*) height of the plants, (*c*) dry weight of grains, (*d*) dry weight of roots, and (*e*) dry weight of tops. The experimental data under each criterion were obtained as follows:

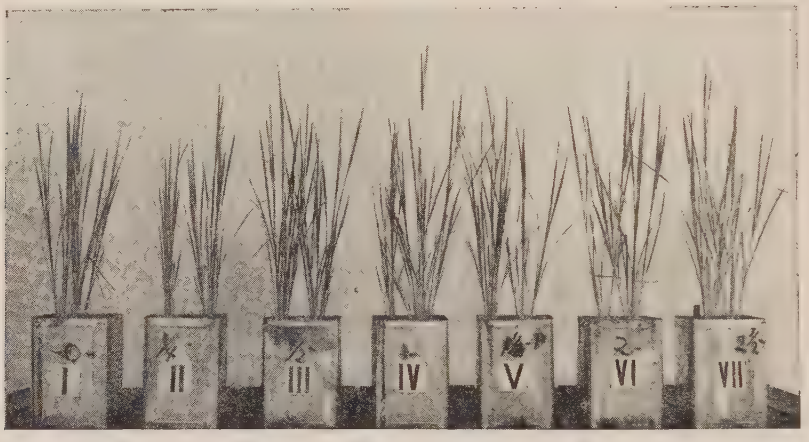

Fig. 2.—Rice plants at booting stage grown in Lipa clay loam supplied with superphosphate. Cultures I (control), no fertilizer; II, 1.38 grams; III, 2.75 grams; IV, 5.5 grams; V, 8.25 grams; VI, 11.0 grams; and VII, 13.75 grams of superphosphate. (Experiment from July 18, 1937, to October 31, 1937).

Number of tillers. At booting stage, the number of tillers of the two plants in each pot were counted and recorded. The average data in the tables were obtained by adding together the number of tillers in similar cultures and dividing the sum by the number of replications.

Height of plants. The data on the height of plants were obtained at the time of harvest. Measurements were made from the base of the culms to the tip of the tallest leaf in each culture. The data thus obtained from the three similar cultures were averaged.

Dry weight of grains. The harvested panicles from each culture were placed in a paper bag properly labelled, dried first in the sun, and then in the electric oven to a constant weight. After obtaining the weight of the panicles from one culture, the grains were separated and weighed. The data thus obtained from the three similar cultures were averaged.

Dry weight of roots. After the tops had been harvested, the roots were removed from the pot, washed with water, and dried in the sun. Then they were put in paper bags, labelled, placed in an electric oven to dry to constant weight, and weighed. The weights of the roots from the three similar cultures were averaged.

Dry weight of tops. After the panicles had been harvested, the straw from each culture was cut close to the roots, bundled, labelled, dried first in the sun and then in the electric oven to a constant weight, and weighed. To the data from the three similar cultures were added the weights of the dried panicles from the same cultures, and the results were averaged by dividing by three.

Care of cultures

The cultures were exposed to direct sunshine. They were watered, cultivated, and weeded as often as necessary. Care was taken to protect them from pests.

DISCUSSION OF RESULTS

Effects of ammonium sulfate

The cultures fertilized exclusively with varying amounts of ammonium sulfate were run to find out if results would be similar to those previously obtained by Soriano (1934) and Almeda (1937). The results (tables 1 and 2 and fig. 1) from the present study confirm fairly well the findings of these workers.

The data in tables 1 and 2 plainly show that, with the few exceptions as to number of tillers, increases in the amounts of ammonium sulfate used resulted in increase in vegetative growth and yield of grain. The best results appear to have been obtained from cultures V and VI. When the two highest values under each criterion were arbitrarily selected and indicated by H's in the two tables, all or most of the H's fall in these two cultures. These received the two highest applications of ammonium sulfate tried, culture V receiving 8.25 grams, or at the rate of 1½ tons per hectare, and culture VI, 11.0 grams, or at the rate of 2 tons per hectare. According to tables 1 and 2 and fig. 1, of the two cultures, VI gave better results. Therefore, in this study, the addition of 11.0 grams (or 2 tons per hectare) of ammonium sulfate to 19 kilograms of air-dry Lipa clay loam gave the best growth and the highest yield of grains and tops of the upland rice.

Effects of superphosphate

The data in tables 3 and 4, as well as fig. 2, plainly show that the superphosphate-fertilized cultures did not differ much from one another and were not much better than the unfertilized, or control, cultures. The improvement of some of the fertilized cultures over the control was so little that it was almost negligible, considering the rather wide range of fertilizer applications tried. In this study, this fertilizer was tried at amounts ranging from 1.38 to 13.75 grams per pot, or at the rates of from ½ ton to 2½ tons per hectare.

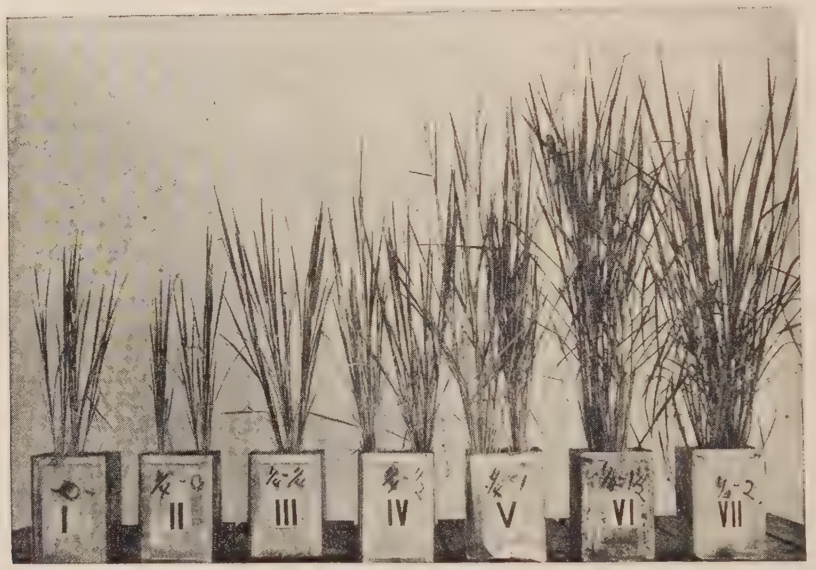

Fig. 3a.—Rice plants at booting stage grown in Lipa clay loam supplied with 1.78 grams superphosphate and varying amounts of ammonium sulfate. Cultures I (control), no fertilizer; II, 1.38 grams, superphosphate; III, 1.38 grams each of superphosphate and ammonium sulfate; IV, 1.38 and 2.75; V, 1.38 and 5.5; VI, 1.38 and 8.25; VII, 1.38 and 11.0 grams of superphosphate and ammonium sulfate, respectively. (Experiment from July 18, 1937, to October 31, 1937).

If the Lipa clay loam used really lacked P_2O_5, or phosphate, for the upland rice plants, it should not be as much as the larger amounts shown in tables 3 and 4. Thus, the little improvements of some of the fertilized cultures, especially those that received relatively large amounts of superphosphate, over the control, might have been due, not so much to the addition of phosphate, or P_2O_5, to the soil, but probably, at least in part, to the addition of rather large amounts of calcium and impurities present in superphosphate fertilizer. Therefore, it appears that the addition of superphosphate fertilizer to Lipa clay loam is not necessary to obtain good growth and yield of upland rice, variety Inintiw.

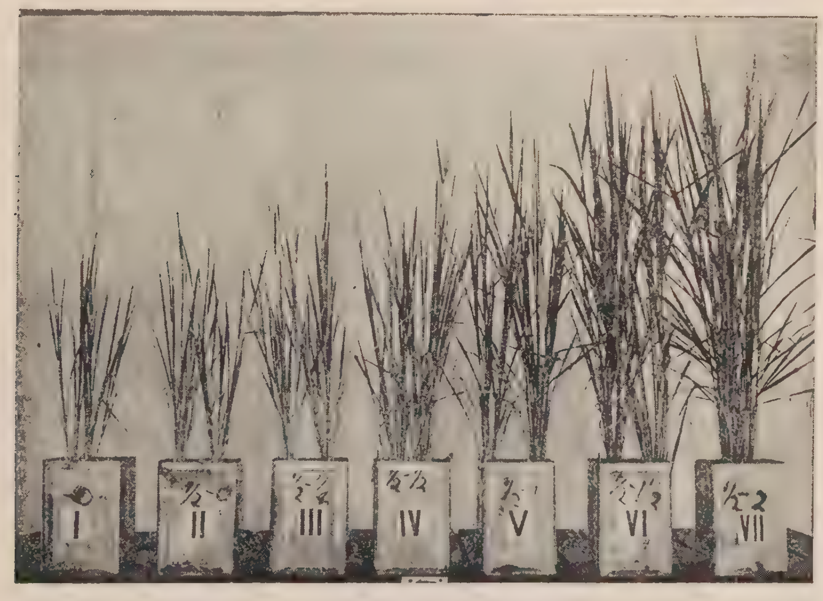

Fig. 3b.—Rice plants at booting stage grown in Lipa clay loam supplied with 2.75 grams superphosphate and varying amounts of ammonium sulfate. Cultures I (control), no fertilizer; II, 2.75 grams superphosphate; III, 2.75 and 1.38; IV, 2.75 and 2.75; V, 2.75 and 5.5; VI, 2.75 and 8.25; VII, 2.75 and 11.0 grams of superphosphate and ammonium sulfate, respectively. (Experiment from July 18, 1937, to October 31, 1937).

Effects upon upland rice of superphosphate when added with ammonium sulfate to Lipa clay loam

Inasmuch as the culture designations in tables 5 and 6 are not the same as those in fig. 3a to 3e, it might be well to consider the data in these two places separately.

In fig. 3a, as in subsequent figures 3b to 3e, culture I is the control, or the unfertilized, culture. The subsequent cultures, from II to VII, were fertilized with the same amount of superphosphate but with increasing amounts of ammonium sulfate. As arranged in these figures and judged by the relative stands of the plants, the cultures show that the growth and development of the plants were influenced, not by the amount of superphosphate fertilizer employed, but by the amounts of ammonium sulfate added to the soil, for in fig. 3a to 3e, it is shown that, in a general way, the greater the amount of ammonium sulfate, the better was the development of the rice plants.

In tables 5 and 6 (excluding culture I, control), the cultures are arranged in five groups with five cultures in each. Each group received a fixed amount of ammonium sulfate with varying amounts of superphosphate. Thus arranged, comparison of cultures becomes rather simple. It is evident that the experimental data in each compartment show neither an ascending nor a descending order, in spite of the fact that the amounts of superphosphate employed are arranged from the lowest to the highest. This fact, therefore, seems to indicate that the applications of varying amounts of superphosphate with

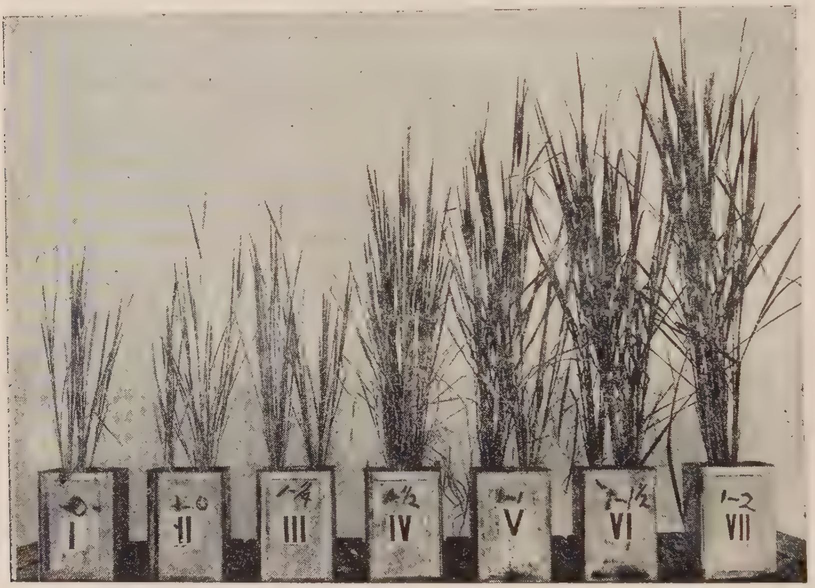

Fig. 3c.—Rice plants at booting stage grown in Lipa clay loam supplied with 5.5 grams of superphosphate and varying amounts of ammonium sulfate. Cultures I (control), no fertilizer; II, 5.5 grams superphosphate; III, 5.5 and 1.38; IV, 5.5 and 2.75; V, 5.5 and 5.5; VI, 5.5 and 8.25; VII, 5.5 and 11.0 grams of superphosphate and ammonium sulfate, respectively. (Experiment from July 18, 1937, to October 31, 1937).

a certain amount of ammonium sulfate to the culture media had an indifferent effect upon the plant.

When the five highest and six lowest values in tables 5 and 6 are arbitrarily selected and indicated by H's and L's, it will be seen that most of the H's segregate toward the lower part of the tables. On the other hand, most of the L's seem to segregate toward the upper part of the tables. Most of the H's fall in cultures that received 8.25 grams and 11.0 grams of ammonium sulfate, irrespective of the amount of superphosphate present in the culture, whereas most of the L's fall in the cultures that received 1.38 grams of ammonium sulfate, again irrespective of the amount of superphosphate employed. It appears, therefore, that the good growth and high yields of the plant were obtained from the cultures that received relatively high amounts of ammonium sulfate, and that the poor results were obtained from the cultures that received relatively low amounts of the fertilizer, irrespective of the amount of superphosphate used.

It should be pointed out that, according to the criteria employed, even the poorest fertilized cultures in tables 5 and 6 are not any worse than the corresponding control, or unfertilized, culture. This difference, however, was most probably due, not so much to the amount of superphosphate added, but to the amount of ammonium sulfate used. (See also table A.)

TABLE A

CULTURE NO.[a]	AMOUNT OF FERTILIZERS APPLIED		DRY WEIGHT OF[b]		TAKEN FROM TABLE	TIME OF EXPERIMENT
	Ammonium sulfate	Superphosphate	Grains	Tops		
	grams	*grams*				
VIa	11.0	0	355	400	5	July 18 to Oct. 31, 1937
XXIIIa	11.0	2.75	364	450	5	
Ia	0 (control)	0	100 (13.4 gm)	100 (30.9 gm)	1 or 5	
VIb	11.0	0	300	341	2	Aug. 28 to Dec. 5, 1937
XXIIIb	11.0	2.75	322	373	6	
Ib	0 (control)	0	100 (13.7 gm)	100 (31.3 gm)	1 or 6	

[a] The same culture numbers as in tables 1 to 6; addition of *a* or *b* was made to distinguish the cultures in the first set from the similar cultures in the second set.

[b] The actual value under each criterion in the control culture was arbitrarily taken as 100 and the actual values for the fertilized cultures under the same criterion were reduced relatively in terms of the assumed value for the control.

In the foregoing table A, cultures VIa, from table 1; XXIIIa, from table 5; and Ia, from table 1 or 5 are shown. Cultures VIb, from table 2; XXIIIb, from table 4; and Ib, from table 6, are likewise shown, together with the corresponding control cultures. Owing to irregularities in results, it was found not quite possible to select, on the basis of all the criteria employed, the best culture in table 5 and the best in table 6. It happened, however, that in terms of the yield of grains, which is the best indicator of result known, culture XXIII appears in both tables. Hence, this culture is selected, and its yields of grains and of tops are compared in relative values with those from the best ammonium sulfate culture and corresponding control culture.

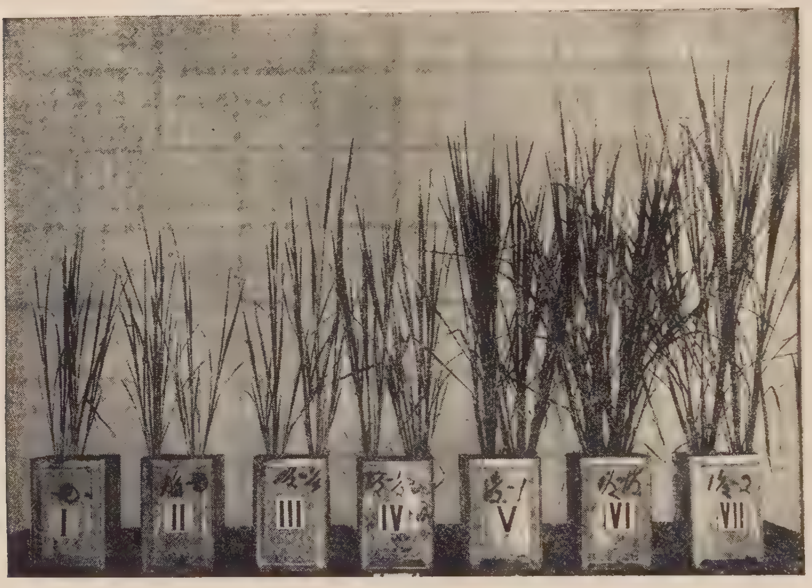

Fig. 3d.—Rice plants at booting stage grown in Lipa clay loam supplied with 8.25 grams superphosphate and varying amounts of ammonium sulfate. Cultures I (control), no fertilizer; II, 8.25 grams superphosphate; III, 8.25 and 1.38; IV, 8.25 and 2.75; V, 8.25 and 5.5; VI, 8.25 and 8.25; VII, 8.25 and 11.0 grams superphosphate and ammonium sulfate. respectively. (Experiment from July 18, 1937, to October 31, 1937).

The results of the comparisons reveal the fact that culture XXIIIa in table A is somewhat better than culture VIa. Since the former contained 11.0 grams of ammonium sulfate and 2.75 grams of superphosphate, and the latter had only 11.0 grams of ammonium sulfate, it may be suspected that the slight improvement of culture

XXIII over culture VI might have been due to the small amount of superphosphate that was added. Therefore, the addition of superphosphate with ammonium sulfate to Lipa clay loam produced a slight increase in the yield of grain and of tops over the culture that received ammonium sulfate alone. The increase was so little, however, that the beneficial effects derived from the application of superphosphate may probably be considered negligible.

As shown in table A, the improvement of the yields from the selected fertilized cultures over the corresponding control culture was decidedly much greater. For instance, in the first set, in terms of average of the data on dry weight of grains and dry weight of tops in each culture, XXIIIa was 407 per cent better than the control, and in the second set, XXIIIb was 347 per cent better than the corresponding control culture. Therefore, the addition of 2.75 grams (or ½ ton per hectare) of superphosphate with 11.0 grams (or 2 tons per hectare) of ammonium sulfate to Lipa clay loam may be considered as exceptionally good for the upland rice plant. It should, however, be pointed out that, as shown in previous discussions, the decidedly beneficial effects of this mixture was largely due to the relatively large amount of ammonium sulfate employed. For this reason, the addition of superphosphate with ammonium sulfate to the soil for upland rice can not be justified. Probably the best fertilizer to apply to Lipa clay loam for upland rice would be ammonium sulfate at the rate of two tons per hectare.

Addition of superphosphate to Lipa clay loam containing large amounts of ammonium sulfate

Most of the harmful effects upon upland rice allegedly caused by excess application of ammonium sulfate to Lipa clay loam were not observed in the present study. For instance, nothing unusual was noticed among the cultures supplied with the mixed fertilizers regarding time of flowering. Neither was there noticed any consistent decrease of yield of grains and tops of the plant following heavy applications of ammonium sulfate. This was probably because the highest amount of ammonium sulfate when used alone or in combinations with superphosphate, as was the case in this study, turned out to be either the best culture (tables 1 and 2), or exceptionally good ones among the mixed fertilizers tried. In other words, truly excessive application of ammonium sulfate was not reached in this study.

The lack of uniformity in the degree of ripening of the grains on the same panicle was observed following the use of sulfate of ammonia, especially when this fertilizer was used in relatively large amounts. Casual observations have shown that a few grains with rather green hulls were always found on panicles on which most of the grains had already turned yellow and, therefore, had already reached full maturity. It is probably safe to say, therefore, that the additions of superphosphate with ammonium sulfate to Lipa clay loam failed to eliminate altogether the characteristic lack of uniformity of ripened grains on the panicle produced following a heavy application of ammonium sulfate alone.

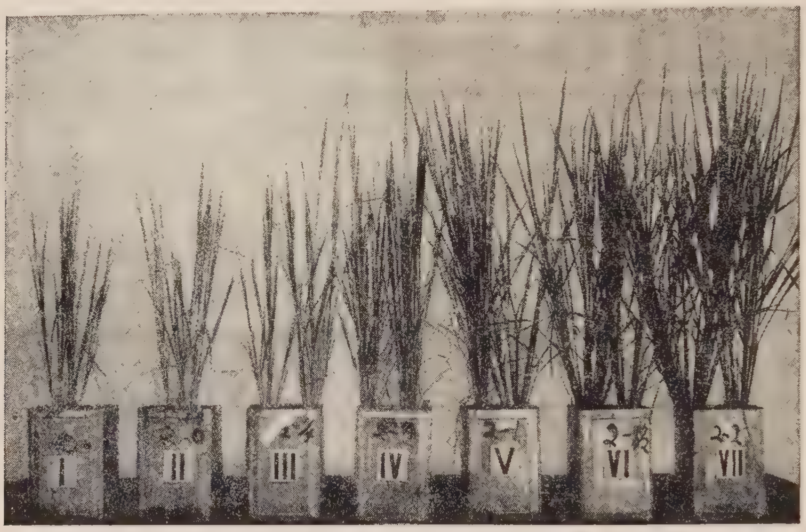

Fig. 3e.—Rice plants at booting stage grown in Lipa clay loam supplied with 11.0 grams superphosphate and varying amounts of ammonium sulfate. Cultures I (control), no fertilizer; II, 11.0 grams superphosphate; III, 1.0 and 1.38; IV, 11.0 and 2.75; V, 11.0 and 5.5; VI, 11.0 and 8.25; VII, 11.0 and 11.0 grams superphosphate and ammonium sulfate, respectively. (Experiment from July 18, 1937, to October 31, 1937).

SUMMARY OF CONCLUSIONS

1. The addition of 11.0 grams (or 2 tons per hectare) of ammonium sulfate to 19 kilograms of air-dry Lipa clay loam gave the best growth and highest yield of upland rice plant, variety Inintiw.

2. It appears that a good growth and yield of upland rice when grown in Lipa clay loam does not require the addition of superphosphate fertilizer.

3. The application of varying amounts of superphosphate with a certain amount of ammonium sulfate to the culture media had no effect upon the plant.

4. It appears that the good growth and high yields of the plant were obtained from the cultures that received relatively large amounts of ammonium sulfate, and that the poor results were obtained from the cultures that received relatively low amounts of the same fertilizer, irrespective of the amount of superphosphate used.

5. The addition of superphosphate with ammonium sulfate to Lipa clay loam produced a small increase in the yield of grain and of tops over the culture that received the ammonium sulfate alone. The increase was so slight, however, that whatever beneficial effects may have been derived from the application of superphosphate may probably be considered as negligible.

6. The addition of superphosphate with ammonium sulfate to Lipa clay loam failed to eliminate altogether the characteristic lack of uniformity of ripened grains on panicles generally produced following heavy applications of ammonium sulfate alone.

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TABLE 1

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with varying amounts of ammonium sulfate fertilizer

(EXPERIMENT FROM JULY 18, 1937, TO OCTOBER 31, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER USED	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF		
				Grains	Roots	Tops
	grams		*cm.*	*grams*	*grams*	*grams*
I	0 (control)	7.5	113.0	13.4	4.8	30.9
II	1.38	11.0	125.0	17.3	8.3	41.3
III	2.75	12.3	126.7	19.8	8.5	46.2
IV	5.50	16.0	131.3	30.4	9.0	76.5
V	8.25	20.3 H	153.0 H	40.3 H	9.9 H	110.9 H
VI	11.00	19.0 H	152.0 H	47.5 H	14.2 H	124.1 H

TABLE 2

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with varying amounts of ammonium sulfate fertilizer

(EXPERIMENT FROM AUGUST 28, 1937, TO DECEMBER 5, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER USED	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF		
				Grains	Roots	Tops
	grams		*cm.*	*grams*	*grams*	*grams*
I	0 (control)	9.3	108.5	13.7	3.0	31.3
II	1.38	10.3	127.7	14.5	3.8	37.6
III	2.75	15.0 H	117.7	19.4	4.6	50.1
IV	5.50	14.7 H	128.0	29.3	6.5 H	77.1
V	8.25	14.3	138.0 H	37.6 H	5.7	89.7 H
VI	11.00	13.7	139.3 H	41.0 H	6.2 H	106.7 H

TABLE 3

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with varying amounts of superphosphate fertilizer

(EXPERIMENT FROM JULY 18, 1937, TO OCTOBER 31, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER USED	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF Grains	DRY WEIGHT OF Roots	DRY WEIGHT OF Tops
	grams		*cm.*	*grams*	*grams*	*grams*
I	0 (control)	7.5	113.0	13.4	4.8	30.9
II	1.38	6.5	107.8	13.0	4.9	29.1
III	2.75	7.8	111.3	14.2	7.2	32.4
IV	5.50	9.5	110.8	12.1	5.3	29.1
V	8.25	6.5	113.0	14.9	5.7	34.1
VI	11.00	8.4	119.3	13.1	4.4	31.2
VII	13.75	8.3	119.3	15.2	4.6	35.3

TABLE 4

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with varying amounts of superphosphate fertilizer

(EXPERIMENT FROM AUGUST 28, 1937, TO DECEMBER 5, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER USED	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF Grains	DRY WEIGHT OF Roots	DRY WEIGHT OF Tops
	grams		*cm.*	*grams*	*grams*	*grams*
I	0 (control)	9.3	108.5	13.7	3.0	31.3
II	1.38	9.3	107.8	14.6	2.7	34.5
III	2.75	10.5	113.3	14.7	3.2	35.1
IV	5.50	7.5	113.3	14.9	2.9	34.4
V	8.25	11.0	114.5	11.9	2.8	30.4
VI	11.00	9.5	113.5	14.3	3.2	36.5
VII	13.75	11.5	112.5	14.4	3.1	36.0

TABLE 5

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with different mixtures of ammonium sulfate and superphosphate fertilizers

(EXPERIMENT FROM JULY 18, 1937, TO OCTOBER 31, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER APPLIED		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF		
	Ammonium sulfate	Superphosphate			Grains	Roots	Tops
	grams	*grams*		*cm.*	*grams*	*grams*	*grams*
I	0	0	7.5L	113.0L	13.4L	4.8L	30.9L
II	1.38	1.38	17.3L	125.3L	22.2	9.0L	50.8L
III	1.38	2.75	15.3L	114.7L	18.9L	6.9L	45.9L
IV	1.38	5.50	21.3	112.7L	21.2L	9.8	53.1L
V	1.38	8.25	14.7L	121.0L	15.6L	8.3L	45.7L
VI	1.38	11.00	15.3L	120.3L	17.2L	7.3L	48.3L
VII	2.75	1.38	19.0L	130.0	24.0	9.1	69.0
VIII	2.75	2.75	22.0	133.7	28.4	11.4	78.3
IX	2.75	5.50	25.0	133.3	25.7	10.9	72.5
X	2.75	8.25	19.3	131.3	18.6L	8.6L	61.1
XI	2.75	11.00	21.3	129.0	27.9	10.3	71.2
XII	5.50	1.38	25.3	138.3	38.3	11.2	100.0
XIII	5.50	2.75	21.0	143.7	33.2	11.7	89.2
XIV	5.50	5.50	24.0	151.3	40.6	11.8	93.2
XV	5.50	8.25	25.7	145.7	36.3	9.7	101.9
XVI	5.50	11.00	19.3	152.7H	30.3	14.2H	85.0
XVII	8.25	1.38	23.7	149.3	40.1	11.8	107.8
XVIII	8.25	2.75	26.0	158.3H	45.0	12.1	121.3
XIX	8.25	5.50	23.3	158.0H	47.6H	12.1	138.5
XX	8.25	8.25	22.3	153.3H	41.4	13.3	127.8
XXI	8.25	11.00	26.7H	142.0	47.1H	18.4H	140.8H
XXII	11.00	1.38	28.7H	154.0H	47.6H	16.7H	145.0H
XXIII	11.00	2.75	25.3	149.7	48.7H	14.9H	139.4
XXIV	11.00	5.50	26.7H	145.0	48.1H	11.3	140.1H
XXV	11.00	8.25	29.7H	148.7	41.4	12.5	143.6H
XXVI	11.00	11.00	28.0H	141.7	45.9	18.9H	145.3H

TABLE 6

Average data from cultures of an upland rice grown in Lipa clay loam in pots supplied with different mixtures of ammonium sulfate and superphosphate fertilizers

(EXPERIMENT FROM AUGUST 28, 1937, TO DECEMBER 5, 1937)

CULTURE NO.	AMOUNT OF FERTILIZER APPLIED		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT OF		
	Ammonium sulfate	Superphosphate			Grains	Roots	Tops
	grams	*grams*		*cm.*	*grams*	*grams*	*grams*
I	0	0	9.3L	108.5L	13.7L	3.0L	31.3L
II	1.38	1.38	14.3L	119.7L	21.0L	5.3	50.0L
III	1.38	2.75	14.3L	124.3L	24.0	4.6	53.3L
IV	1.38	5.50	16.7	120.0L	19.4L	6.1	54.8L
V	1.38	8.25	14.3L	124.7	16.9L	6.0	47.7L
VI	1.38	11.00	15.7L	111.0L	18.7L	4.1L	50.9L
VII	2.75	1.38	17.0	125.3	22.8L	5.8	64.8
VIII	2.75	2.75	16.0L	127.0	27.6	3.6L	66.2
IX	2.75	5.50	19.3	125.0	26.8	4.6	76.7
X	2.75	8.25	16.0	124.7	23.3	6.3	73.7
XI	2.75	11.00	21.0	123.0L	28.9	6.2	71.4
XII	5.50	1.38	17.5	136.3	32.8	5.9	86.2
XIII	5.50	2.75	23.0H	130.3	31.7	4.3L	81.9
XIV	5.50	5.50	13.0	127.3	29.4	3.7L	83.9
XV	5.50	8.25	18.7	141.3H	32.8	9.0H	90.4
XVI	5.50	11.00	21.3	129.0	30.7	4.2L	78.6
XVII	8.25	1.38	17.7	136.3	34.6	6.3	98.9
XVIII	8.25	2.75	19.3	131.3	41.4H	7.4H	105.1
XIX	8.25	5.50	22.0H	141.7H	39.0H	6.1	108.0
XX	8.25	8.25	22.7H	139.0H	37.0	7.4H	97.4
XXI	8.25	11.00	22.0H	129.0	37.4	6.6	107.8
XXII	11.00	1.38	21.0	141.0H	35.7	7.7H	109.9H
XXIII	11.00	2.75	20.7	137.7	44.1H	6.5	116.1H
XXIV	11.00	5.50	21.3	141.7H	36.1	5.0	109.2H
XXV	11.00	8.25	24.3H	131.3	40.0H	5.9	110.0H
XXVI	11.00	11.00	21.0	135.3	40.6H	6.8H	114.1H

THE SOUR AND SWEET ORANGES OF KWANGTUNG, CHINA[1]

A. N. Benemerito[2]

WITH NINETEEN TEXT FIGURES

The geographical situation and climatic conditions make Kwangtung Province an important citrus producing center, if not the most important, of China. The fact that the T'im Ch'ang, which Tanaka (1929c) considers to be one of the best in quality among the sweet oranges of the world, and also the Ponkan (*Citrus poonensis* Hort.), one of the best loose-skin oranges, are produced in this province may justify the statement that Kwangtung Province is the producer of the best oranges of the world. Since many forms of these fruits exist which, as far as can be ascertained, are not fully understood by various authors, and because of their importance in the development of the citrus industry of the country, it is the object of this paper to present as full a description of each form as could be gathered from investigation, with the hope of establishing distinct variety names instead of ambiguous ones such as are now used in the market and in the field. These names usually mean two or more forms of oranges.

The ambiguity of the terms used by the citrus growers may be illustrated by the following: During the citrus exhibition held at Canton in 1933, there were no less than 34 varietal names of sweet oranges exhibited. Each of the variety names does not necessarily mean a distinct variety because two or more names often mean one form of orange, and sometimes one name may mean two or more forms. For example, Heung Shui Ch'ang, Shui Ch'ang, and Heung Ch'ang all mean the same form of orange, the Heung Shui Ch'ang.

Explanation of the terms used

According to my observation and the result of my study of the tight-skin orange of the Canton region in Kwangtung Province, the

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[1] Dr. Tyozaburo Tanaka, visiting Professor of Pomology of the College of Agriculture at Los Baños during the second semester of the academic year 1937-1938, kindly read the manuscript and made valuable changes in it.—Editor

[2] The author wishes to express his gratitude to Dr. F. P. Metcalf, Professor of Botany and Curator of Herbarium, Lingnan University, for valuable suggestions in the description of the different varieties of oranges dealt with in this paper.

English term sweet orange (*Citrus sinensis* Osbeck) is called *Ch'ang* in Cantonese and *Ch'eng* in Mandarin. *Ch'ang* is literally applied to two forms of sweet oranges, the *T'im Ch'ang* and the more acidulous form, known in the market and in the field as *Sueh Ch'ang*. *Sueh Ch'ang* as a name does not mean the true sour orange (*Citrus aurantium* Linn.), which is known by various terms, such as, *Toitoi Kwoh, Tai Ch'ang, Chau Ch'ang, Fu-tau Ch'ang,* etc. In the Chaochow and Swatow regions of the northeastern part of the province, the name Kan (*Kom* in Cantonese) is applied to both the tight and the loose-skin oranges, like the *Ponkan* (*Mat Kom* in Cantonese—the best loose-skin orange of the world) and the *Sui Kan* (*Suet Kom* in Cantonese) for the tight, sweet orange. In Foochow, the term *Gang* is used for the sweet orange, and *Gang Gek* for the small fruited loose-skin. The sour or bitter oranges found in the Amoy and Changchow regions of Fukien Province are known as *Fu-tau Kom* for the loose-skin and, as I shall call it here, *Fu-tau Ch'ang* for the tight-skin, which is supposed to be the true sour orange in these regions. As this paper deals only with the tight-skin oranges, the loose-skin form is omitted and will be treated, together with other species and varieties of oranges, in a separate paper.

HISTORY OF SOUR AND SWEET ORANGES IN CHINA

An investigator on the history of sour and sweet oranges in China must go to the Chinese classical works. Very thorough sinological studies were made by Tanaka,[3] which gave a new light to the first and early references of these citrus fruits. According to his study, the word *ch'eng* is seen, in existing Chinese literature, only in cross references, and no description of it is given in classical works. It is found in the explanatory text of Yu, or *Citrus junos* Sieb. ex Tanaka. Early dictionaries, like Shuo Wen or Erh Ya, compiled before the third century, give the word "Jao" and say that it is identical with the "Yu", which is the fruit "resembling ch'êng and sour". The first Chinese botanical work, Shên Nung Pên ts'ao, compiled sometime before the third century, does not mention "Ch'êng", but a still earlier work, "Book of Edibles Libri 7", is fortunately restored in Japan and is quoted in "Honzô Wamyo", written before the tenth century. The original book mentioned was undoubtedly written before the later Han Dynasty (232-300 A. D.), and gives the first original diagnosis as "Ch'eng resembles the Yu and the size is smaller", and the Japanese work correctly identifies it to be the sour orange, *Citrus aurantium* Linnaeus. In the poem "Yang tu p'u", composed during the 'Ch'ing Dynasty (265-419 A. D.), there is a verse "Yellow kan and red ch'êng", and the latter unquestionably means the sour orange. It is also known that there were 10 ch'êng trees planted in the Shan-lin Palace Garden of Hsi-an, during the reign of the famous Wu-ti in the early Han Dynasty. Although all early literature distinguished ch'êng from Yu, confusion started as early as the Tang Dynasty (618-906 A. D.), and it was carried over to the Sung Dynasty (960-1279 A. D.), as frequent mention is made in such a famous botanical work as Ch'êng lei pen ts'ao that this mistake should be avoided. Ch'êng, unquestionably being introduced from a warmer country, did not last long in a northern city like Hsi-

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[3] TANAKA, T. 1934. A discourse on "Kan" and "Ch'eng" in Chinese in "Honzo" (Herbal) published by Shunyodo, Tokyo, No. 23, p. 1–12.

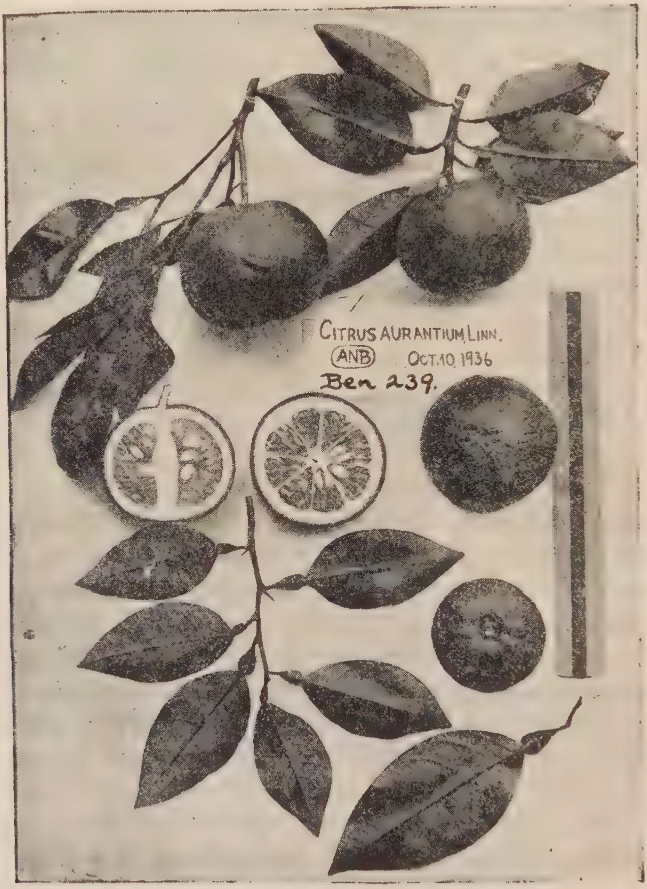

Fig. 1.—Fu-tau Ch'ang, the true sour orange

an, in Shensi Province. *Citrus junos* Sieb must have taken its place as an acid citrus, and so the confusion arose, with Yu considered to mean the sour orange, *C. aurantium* Linnaeus, and simultaneously, Ch'êng to mean the *junos*. This was dealt with by many authors, and even a proverb arose and became a famous saying, "To use tin for separating silver is most likely to discuss ch'êng to define Yu." At least in these early periods, the word ch'êng was never applied to something sweet, such as the present Cantonese use in applying it to the sweet orange. Then, under what name was the sweet orange known to early Chinese—the fruit supposed to be known to the inhabitants of the border region of Ssuchuan and Yunnan, unquestionably brought from eastern part of India where it is indigenous?

The sweet orange introduced from abroad was at first indicated by the term "Kan", the character without a "tree" radical at the left hand side. During the reign of Han Wu-ti (140-87 B. C.), a work supposed to have been written by Tung-fêng-so, a famous sage, says that on the western frontier were abundant occurrences of the "Kan". During the reign of Emperor Kuan (147-168 A. D.) in the later Han Dynasty, there is a work mentioning the "Hung-Kan" (yellow kan), and a great many men of letters of the contemporary period or somewhat later, mentioned this "Yellow Kan" orange, one example of which is given above. It is a very curious fact that this orange was never discussed in any of the botanical works dealing with materia medica. It is perhaps because it has no medical property. A very famous incident is the mention made in the official history of the Han Dynasty that the Governor of Lung-yang hsi en in Hunan Province, planted a thousand trees of "Kan", which he called "Thousand-headed tree coolies". We know, too, that a special officer was created in Po-ning fu in Ssuchuan Province to deal with the local production of the "Yellow Kan" orange, during the Tsin Dynasty (265-419 A. D.). Also frequent mention was made in the works of the Tang Dynasty (618-906 A. D.) about the local production of the "Yellow Kan" orange and its use as an article of tribute. It was listed in a medicinal work for the first time in "Pên ts'ao Shih i", published in 739 A. D., written by Chêng Tzo-chi, but he makes "Milky kan" (Ju kan), the best. Ju kan, or milky kan, was first mentioned in Fêng tu chih, written by Chiu Chou sometime during 265-419 A. D. This milky kan was identified in this work to be "Hu Kan", the bottle Kan, which, however, was first described by Chi Han's Nan fang ts'ao mu chuang, written in 304, A. D., describing the things found in Annam. It likewise occurs in a work written during the middle of the 4th century. "Hu Kan" also appears in the famous "Tang Hsin hsiu pen ts'ao",(Tang Dynasty New Herbal), but the character Hu is written "Iranian" and not "bottle". Anyway, it is a foreign fruit having a very sweet taste and a nipple at the base, quite possibly identical with the Ponkan of Indian origin. The milky orange is supposed to have medicinal property and was first described fully in Shi liao pen ts'ao, a Dietetic Herbal, written in 706 A. D., and later in the famous Cheng lei pên ts'ao, published in 1108. It is very curious that such a well known article as "Yellow Kan" suddenly disappeared during the Sung Dynasty (960-1279), never being listed in official herbals, and that "Milky Kan" made its debut in these Pen ts'aos. If one very carefully reads the text of the famous "Chu lu", a discourse on citrus, written by Han Yen-chih in 1178, it can be noticed that the author simply gives a citation of the "Yellow Kan" orange and never attempts to describe it, whereas he describes "Milky Kan" as a "Real Kan". "Chêng" is much better than that, however, and has a truly globose shape and a very fragrant aroma. The "Milky kan", nevertheless, is more commercially important and an excellent plant to grow profitably. This is how the long forgotten word, "Ch'êng", was revived, but the author unquestionably hesitated to use this confused term and adapted for it another Ch'êng character meaning "door post", a meaningless word used to apply to a new thing. His use of the term "ch'êng", is meant unquestionably to refer to the sweet orange, *Citrus sinensis* Osbeck, as we find the same application in the Canton region. This is the first and very definite application of the word, and entirely neglects the classical usage of designating the sour orange. His usage of the Milky Kan is justified as identical with the early known very sweet, nippled orange, or the Ponkan of the present day. Why the sudden appearance of the sweet orange, then? It must have existed in China for a very long time, an invader from the Indian frontier which was later brought to the Yangtze River region where we still see it at the present time. It was once called the "Coolie" orange of the thousand heads, or better known under the very popular vernacular term, "Hung Kan", or the Yellow Kan orange. The Yellow Kan of the ancient day must have been, without question, the sweet orange. The coolie orange of Europeans of the present day is, fortunately, correct, as it indicates only the tight skinned sweet orange. The term "Hung Kan" has never been lost, in Tanaka's opinion, and the sweet orange is still known under this name in certain parts of Central China. "Kan" is now considered the common name of the loose-skin orange. However, "Shih Kan" (Shek Kan) is a distinct variety of sweet orange in Swatow, Amoy, and Formosa. "Ch'êng" is still used to mean *Citrus junos* in the northern part of Chekiang province,

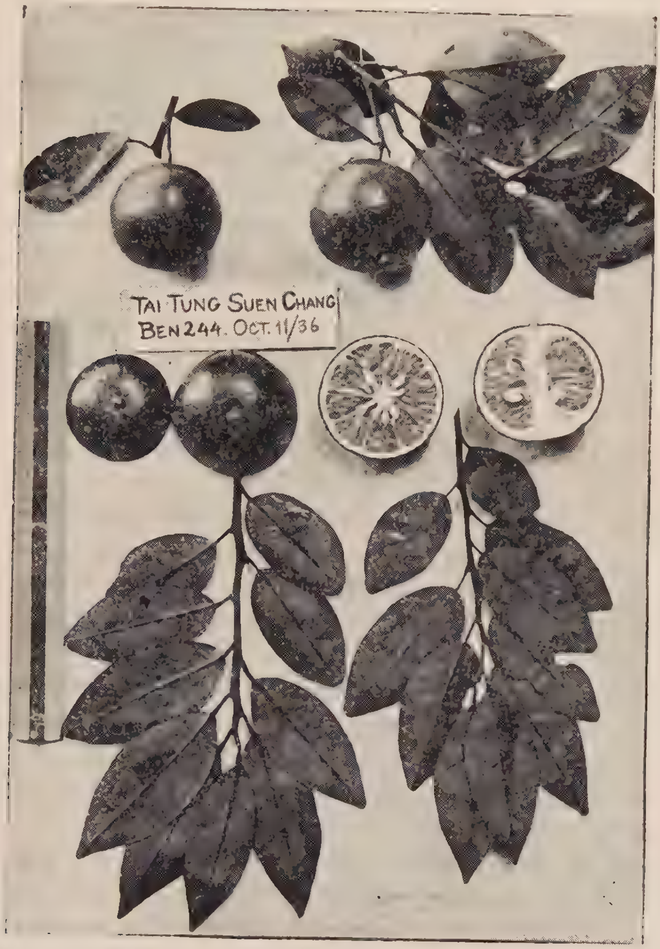

Fig. 2.—Tai-tung Suen Ch'ang

and the sour orange is still partly known under this term in the coastal region of South China.

In 1655, Martini, in his Novus Atlas Sinensia, described two forms of oranges, which Bretschneider (1845) identified: the one with a loose skin is a mandarin orange (*Citrus nobilis* Lour.), and the one with a tight skin is called the coolie orange (*Citrus sinensis* Osbeck).

In 1696, Le Comte, in his Nouveaux Memoires Sur L'etat de la Chine (Vol. I, p. 173), mentions the first orange tree introduced by the Portuguese from China.

In 1704, Joseph Kamel, in his observation of the plants in the Philippines appended to Ray's Historia Plantarum (p. 57), mentioned many Chinese plants. He enumerated 17 forms of oranges, among which is one described as: "aurantium sinense seu Olysiponense vocatum, cortice tenui dulci et sature croceo rubente."

In 1753, Linnaeus, in his Species Plantarum (p. 782-783), treated the sour and sweet oranges together with the pummelo under one species, *Citrus aurantium* Linn. During the time of Linnaeus, the citrus nomenclature was in a state of confusion. The trifoliate orange, which now belongs to the genus *Poncirus*, and the Kumquat, which now belongs to the genus *Fortunella*, were all classified under *Citrus*.

THE POSSIBLE TIGHT-SKIN ORANGES AS RECORDED IN THE GAZETTEERS OF CHINA

According to the Gazetteers consulted, the "ch'êng" occurs in eleven provinces of China, namely, Kwangtung, Kwangsi, Fukien, Chekiang, Kiangsi, Hunan, Sweichow, Szechuan, Anhwei, Kiangsu, and Hupeh. It is very interesting to note that, according to recent investigations on the distribution of the orange, this fruit is found in five provinces, namely, Kwangtung, Fukien, Chekiang, Kweichow, and Yunnan. This shows, therefore, that further investigation is required in order to ascertain its distribution in China at the present time, or it is probable that many of the ancient forms have disappeared from cultivation.

As a matter of reference, the following data are presented on the distribution of the orange fruit as recorded in the Chinese Gazetteers. Since the record of some of the districts is not clear, that is, whether sour or sweet orange is meant, no particular mention to this effect is given in this paper. The orange fruit has been reported in the following districts:

Kwangtung Province: Chao-an, Chao-yang, Chung-shan, Kwong-chow-wan, Meu-ming, Namhoi, Sau-tap, Sunwui, Szwui, Tung-koon, and Yenping.

Fukien Province: Chang-chow, Chuan-chow, Fa-au, Law-yen, Men-chiu, Shan-kan, Ten-chow, Tong-an, and Yen-chuan.

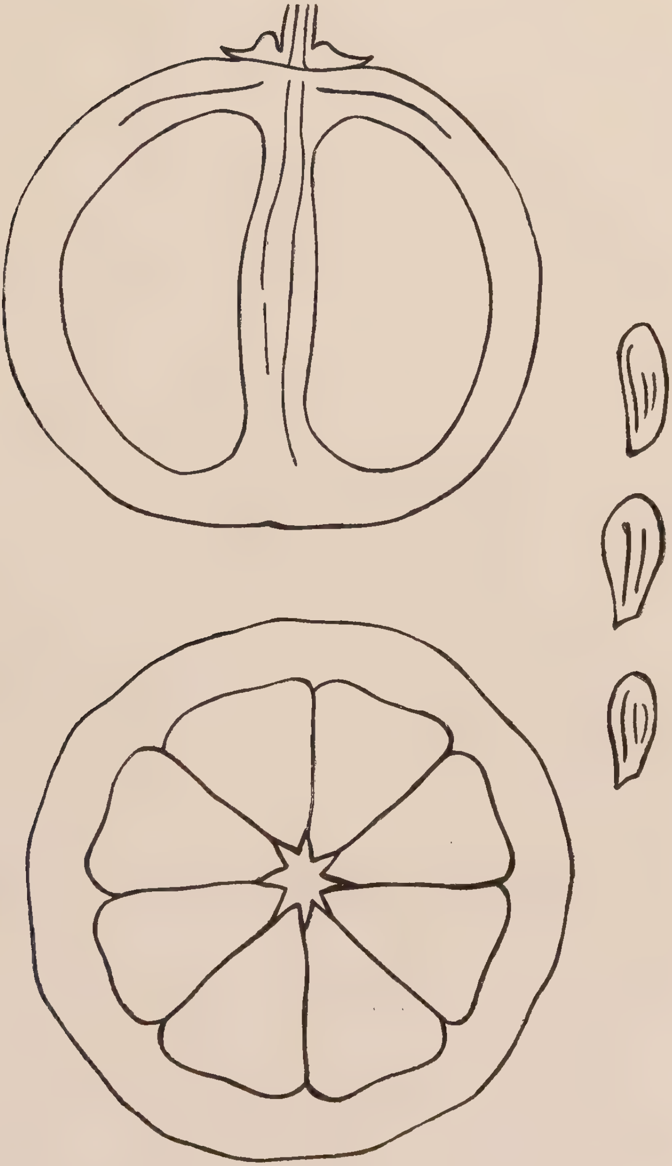

Fig. 3—Toi-toi Kwoh

Chekiang Province: Chang-haw, Huang-yen, Ju-an, Lim-po, Lin-an, and Lin-hai.

Kiangsi Province: Chen-chung, Huang, Kwang-fung, Lu-cheih, Lung-nan, Sin-chen, Tin-nan, and Yung-fung.

Hunan Province: Chang-te, Chu-yan, Kwang-chow, Kwei-yan, Lin-hing, Ping-kiang, and Yu-chow.

Kweichow Province: Kweiyen and Le-ping.

Kiangsu Province: Kiangin and Wu.

Anhwei Province: Mil, Tai-ping, and Wu-yen.

Hupeh Province: Chian-kiang, Chung-chian, Koo-cheng, Nan-chang, She-show, and Yen-sz.

Szechuan Province: Ho-kiang, Kiang-pek, Kwangan, Nan-chuan, Pischian, and Yen-chin.

Distribution of the orange fruit in China

Tanaka and other recent investigators reported the following distribution of the orange fruit in China:

Citrus aurantium Linn. (sour orange), in the following provinces:

Kwangtung	2 varieties
Fukien	1 variety
Chekiang:	
Huangyen	3 varieties
Wenchow	2 varieties
Yunnan	1 variety

Citrus sinensis Osbeck (sweet orange), in the following provinces:

Kwangtung Province:	
Canton	8 varieties
Sunwui	4 varieties
Chao-chao	1 variety
Fukien Province:	
Changchow	1 variety
Foochow	2 varieties
Yunnan Province	1 variety
Kweichow Province	1 variety

Sour and sweet oranges exhibited during the Citrus Fruit Exhibition held at Canton, January to February, 1933

To those who are interested in the study of the orange fruits, a list of the different varieties of sour and sweet oranges is here given together with the district from whence they come.

Citrus aurantium Linn. (sour orange). Of this species, only one variety was exhibited and wrongly labeled *Toi-toi Kwoh,* from P'an-yu District. It should be *Tai Ch'ang,* as the fruit is very large and the calyx not prominent. The *Toi-toi Kwoh* orange is not as big as this, and its calyx is very thick.

Citrus sinensis Osbeck (sweet orange). There were 34 varietal names of sweet orange exhibited, mostly from Kwangtung Province and a few from Kwangsi Province.

Ch'ang: This variety name is the general name for the sweet orange, but in this instance it is used as a particular variety name by the various exhibitors. The specimens exhibited came from the districts of P'an-yu, Lien, Kao-yao, Kao-ming, and Hoh-p'u, all of Kwangtung Province; and from Watlan and Yung-Cheung of Kwangsi Province.

Ch'ang Tsai: The specimen came from Yung District, Kwangsi.

Chi-ch'ang: This is the special variety of Navel orange from P'an-yu District, Kwangtung.

Heung-Ch'ang: The specimen came from P'an-yu District.

Heung-fa Lau Ch'ang: From Tseng-Cheng District.

Heung Shui Ch'ang: From Sin-hwei, Chung-shan, Nan-hoi, Sze-hwei, P'an-yu, and Tseng-cheng.

Hung-pei Kwong-sun Ch'ang: From P'an-yu District.

Hung-pei Lau Ch'ang: From P'an-yu District.

Kam-shan Ch'ang: From P'an-yu and Chung-shan Districts.

Kap Ch'ang: From P'an-yu District.

Kwong-sun Ch'ang: From P'an-yu District.

Lau Ch'ang: From P'an-yu, Chung-shan, Nan-hoi, and Tsung-hwa Districts.

Lo-shue Ch'ang: From Tseng-cheng District.

Lo-shue Lau Ch'ang: From P'an-yu District.

Ming Lau Ch'ang: From the districts of P'am-yu, Chung-shan, and Tseng-cheng.

Mo-wat Lau Ch'ang: From Tseng-cheng District.

Ngo Tan T'im Ch'ang: From P'an-yu District.

Nin Ch'ang: From P'an-yu District.

Nin Man Ch'ang: From P'an-yu District.

Nuen-shue Ch'ang: From Tseng-cheng District.

Om Lau Ch'ang: From Sin-hwei, Chung-shan, Nanhoi, P'an-yu, Tseng-cheng, and Sze-hwei.

Shang Chang Tsai: From Ch'ao-an District.

Shiu Heung Shui Ch'ang: From P'an-yu District.

Shui Ch'ang: From P'an-yu District.

Suen Ch'ang: From P'an-yu District.

Suen Shui Ch'ang: From Tseng-cheng District.

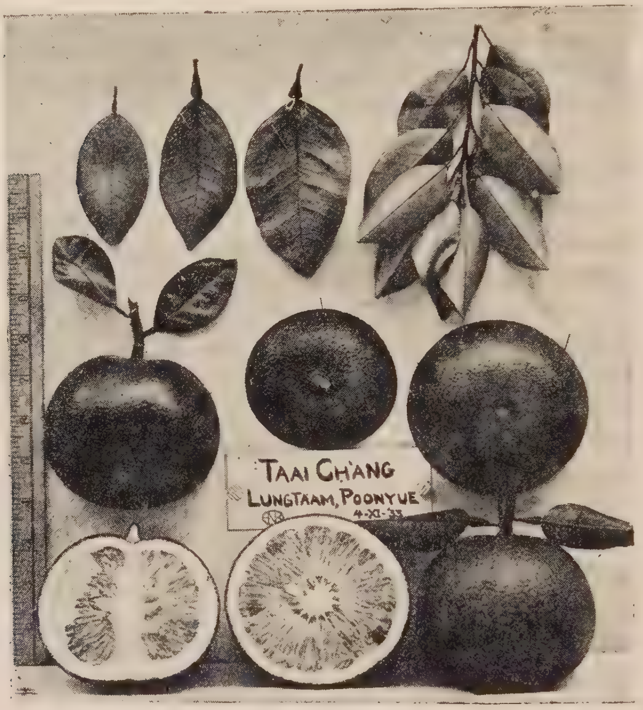

Fig. 4.—Lung-taam Tai Ch'ang

Tai-Hung Ch'ang: From P'an-yu District.

T'im Ch'ang: From P'an-yu, Sin-hwei, and Tseng-cheng Districts.

T'im Lau Ch'ang: From Sin-hwei District.

Tit-sin Lau Ch'ang: From P'an-yu District.

Wong-pei Lau Ch'ang: From P'an-yu District.

Yau-ip Lau Ch'ang: From Tseng-cheng District.

Yeung-si Lau Ch'ang: From Tsung-hwa District.

TAXONOMIC POSITION OF THE SOUR AND SWEET ORANGES

Position of the Genus Citrus

According to Engler, the sour and sweet oranges are classed under Subfamily Aurantioideae, Tribe Aurantieae, Genus *Citrus,* and Subgenus *Eucitrus.* Swingle, on the other hand, classified these citrus forms under the Subfamily Citrateae, Tribe Citrinae, Subtribe Citrae, Genus *Citrus.* Tanaka classed them in a still different way, that is, Subfamily Aurantioideae, Tribe Aurantieae, Subtribe Citrinae, Genus *Citrus,* Subgenus *Archicitrus.* Under this subgenus, Tanaka classified the following genera as sections:

a. Papeda, the Papeda of Hasskarl, to which *Citrus hystrix* DC. belongs.

b. Limonellus, the Limonellus of Rumphius, to which *Citrus aurantifolia* Swingle belongs.

c. Citrophorum, the Citrophorum of Necker, to which *Citrus limonia* Osbeck belongs.

d. Aurantium, the Aurantium of Turnefort, to which the sour and sweet oranges (*C. aurantium* Linn. and *C. sinensis* Osbeck) belong.

e. Cephalocitrus of Tanaka, to which *Citrus grandis* Osbeck belongs.

The genus Citrus Linnaeus

Shrubs or trees, usually with spiny branches. Leaves persistent, unifoliate, alternate, thick, and leathery, dotted with translucent oil glands; petiole generally more or less winged. Flowers solitary, clustered or in lateral cymes or panicles, usually bisexual, white or purplish pink, scented; calyx small, cup-like; lobes 4-5; petals 4-6, linear oblong, thick, imbricated; stamens 15-60, usually polyadelphous rarely nearly separate, inserted round a cupular or annular disk; ovary 8-15-celled, with large deciduous style; ovules, several in each cell arranged mostly in two rows. Fruit, a large berry, globose, subglobose, ovoid, oblong, or oblate; rind well provided with oil cells; none to several seeds in each locule or segment.

Citrus is a classical Greek name, first applied to another tree. According to modern authorities, there are over 100 species native of southeastern Asia, including India, China, Japan, Indo-China, Malayan Islands, and the Pacific regions.

Key to the species

A. Calyx lobes in fruiting stage, rather regularly cut, always pubescent on both surfaces. Oil cells of the rind very close, distinctly graded in size, and some safely convex. Color of the rind never intensely reddish. Pulp vesicles numerous, wall elastic, and always contain characteristic high-flavored juice not intensely acid when ripe. Seeds broad, pale in color, striation often oblique, even transverse, and those at ends are attached more or less perpendicular in position .... *C. sinensis* *Osbeck.*

B. Calyx lobes in fruiting stage, rather irregularly cut with tapering apex, and always glabrous on both surfaces. Oil cells of the rind rather dispersed, not distinctly graded, and either flat or concave. Color of the rind often quite reddish. Pulp vesicles large and not numerous, with a rather weak, easily perishable wall, containing acid juice with a slight bitterish after-taste. Seeds rather slender, straw-yellow, striation parallel and never transversely arranged. Attachment of seed always horizontal .... *C. aurantium* Linn.

THE SOUR ORANGE

Citrus aurantium Linn., Sp. Pl. 782. 1753; Merr., Commen. Lour. Fl. Cochinch. 224. 1935; *C. vulgaris* Risso, Ann. Mus. Hist. Nat. Paris, XX: 190. 1813; Hume, Citrus fruits and their culture. 3rd. ed. 16, 1909.

A glabrous, medium-sized tree, with rounded top and regular branches, young shoots light green, thorny, spines small in the younger branches, sharp pointed, on the older wood, strong and stiff. Leaves light green when young, oblong-ovate to ovate, 6.5 to 13 centimeters or more long. shortly or bluntly acuminate, sometimes rounded or very shallowly indented at the tip, the base usually acute, margin sinuate or crenate; petiole broadly or sometimes narrowly winged. Inflorescence axillary or subterminal, flowers clustered, white, and very fragrant; calyx cupped, 4-5-lobed, pubescent; alabaster slender, often constricted at the middle, petals white on both sides, linear, oblong, conspicuously dotted with oil cells, 11-18 mm. long strongly recurved; stamens 20 or more; filaments united in groups; pistil club-shaped, smooth; ovary globular, 6-14-celled. Fruit globose and slightly flattened, about 8 cm. or more in diameter; orange color or reddish at maturity, inclined to be rough; rind tight, strongly aromatic, bitter; pulp juicy and acidulous; membranes bitter; core hallow at maturity; segments 10 to 12; seeds flattened and wedged toward the micropylar end, longitudinally striated.

Aurantia is a pre-Linnean name for the orange.

Economic and commercial uses

In southern Europe, the sour orange is grown extensively for making marmalade and essential oil from the flowers is used for perfumery. The seedlings are grown in various citrus producing centers of the world for stock on which to graft other species of

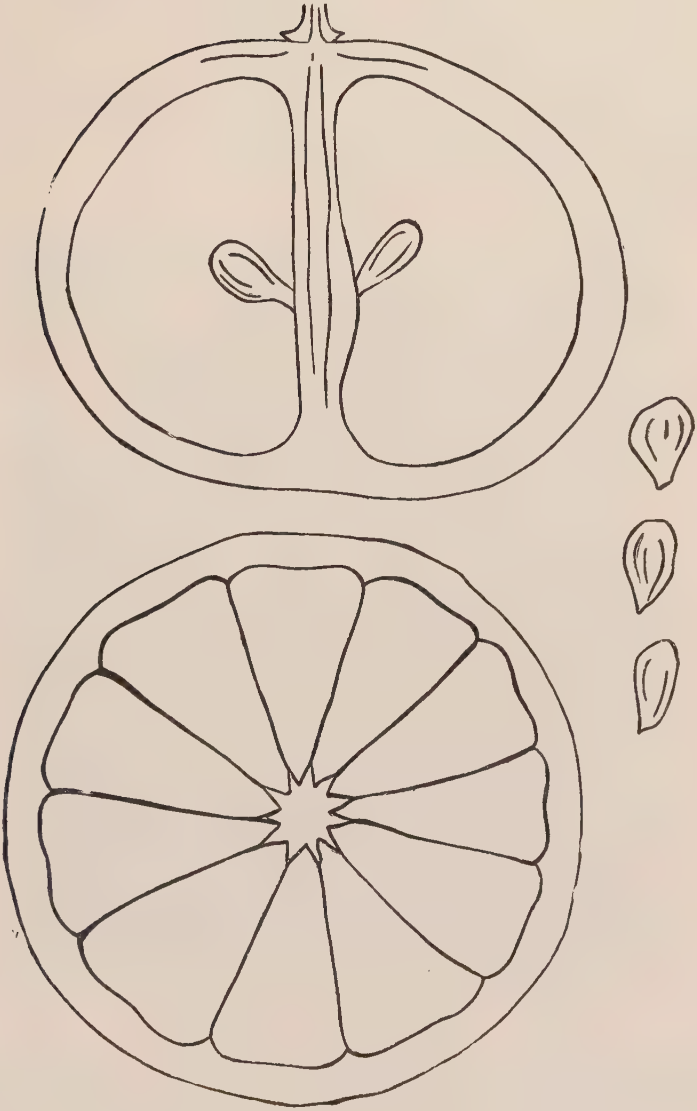

Fig. 5.—Tai Suen Ch'ang

citrus. In China, this species is mostly grown as an ornamental; the fruit is used in worship and is displayed on the table. The flowers are also used to some extent in perfumery.

Key to the varieties of sour orange

A. Fruit small, not more than 8.5 cm. diameter, skin dark orange and tightly attached to the carpel.
  B. Calyx very much raised and prominently lobed .... *3. Toi-toi Kwoh.*
  B. Calyx rather thin and inconspicuously lobed.
    C. Fruit smooth surface; leaves petioles narrowly winged .... *2. Tai-tung Suen Ch'ang.*
    C. Fruit rather rough or with an uneven surface, leaves petiole broadly winged .... *1. Fu-tau Ch'ang.*
A. Fruit large, not less than 8.5 centimeters diameter, skin light orange and not very tightly attached to the carpel.
  B. Leaves small and narrow, finely crenate .... *6. Szwui Chau Ch'ang.*
  B. Leaves large and broad, conspicuously crenate.
    C. Oil cells rather flat, seed shallowly striated .... *5. Tai Suen Ch'ang (Tai Kom).*
    C. Oil cells projecting, seeds large, more deeply striated .... *4. Lung-Taam Tai Ch'ang.*

1. FU-TAU CH'ANG. The true sour orange. Fig. 1.

A spiny tree, upright; trunk with long, thick spines; spines on terminal and fruiting branches 3 to 12 mm. long, shorter at the end of the branches. Leaves of terminal and fruiting branches oval to elliptical ovate; blade 4.3 to 12.4 cm. long or more, 2.5 to 6.3 cm. or more wide at the broadest part, margin entire or very finely crenate; petiole usually broadly winged, 8 to 30 mm. or more long, 4 to 15 mm. or more at widest part. Fruit more or less oblate or subglobose, attached usually obliquely to the stem; calyx end: calyx small, narrowly lobed, stem 4 to 5 mm. thick or thicker, flat or slightly depressed at the stem attachment; pistil end: flat or rounded, very slightly depressed, at center is a pistil scar of 2 mm. diameter; longitudinal diameter 6 to 7 cm. or more long, latitudinal diameter 7.5 or less to 8.3 cm. wide; rind 6-8 mm. or more thick, somewhat uneven when magnified, sometimes with projection on the side, tightly attached to the carpel, deep or reddish orange at maturity; oil cells small, not conspicuously projecting; pith or core solid or somewhat hollowed, 12 to 14 mm. at the thickest part; sections or segments usually 8, sometimes more; flesh light orange or orange at maturity, very juicy; taste sour with bitter taste; seeds few to many, rather thick, striated, 12 to 16 mm. or more long, 6 to 8 mm. or more at thickest part; outer skin whitish cream, sometimes with very light green patches near the point of attachment; inner coat light reddish or dirty brown, purplish brown at the part covering the tip end; embryo somewhat whitish green.

This variety is called here *Fu-tau Ch'ang* to distinguish it from the loose-skin form (*Fu-tau Kom*). Their habit characters are alike, differing only in the size of the fruit and of the looseness of the rind. This variety has a smaller fruit with a tight skin, whereas the *Fu-tau Kom* is very much larger, oblate in form, and has a loose skin. It is represented by the specimens Ben 239 and Ben F-16. The former was introduced from the Philippines, and the latter was collected by the author from Fukien Province.

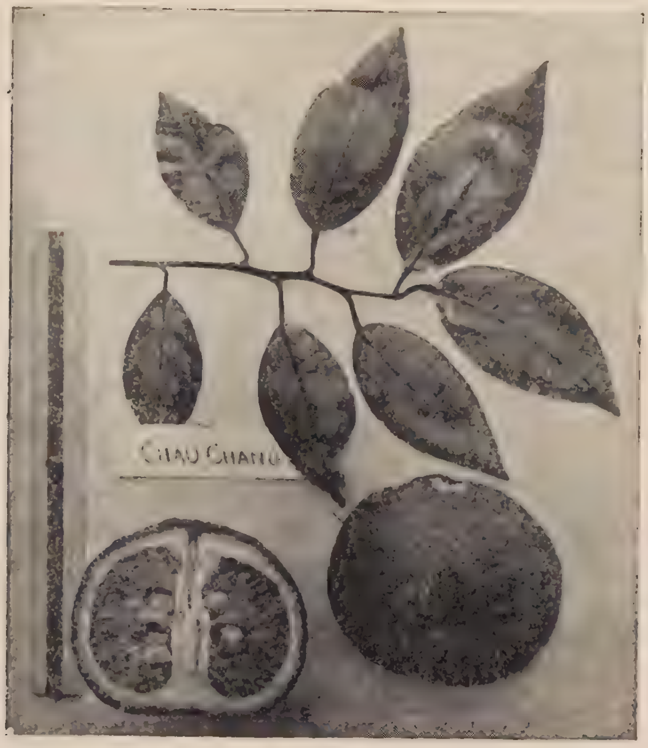

Fig. 6.—Szwui Chau Ch'ang

2. TAI-TUNG SUEN CH'ANG. Fig. 2.

An almost spineless, low-branching tree. Leaves of terminal or fruiting branches, rather narrow, oval to elliptical ovate; blade 6 to 10 cm. or more long, 3 to 4.8 cm. or more at the broadest part, margin very finely or indistinctly crenate (when seen in the light), tip blunt, shallowly or deeply indented, dark green above, lighter below, thick and leathery; petiole margined to slightly broadly winged, 7 to 15 mm. or more long, 2 to 4 mm. or more at widest part. Fruit subglobose or ball-like form; calyx end rounded, fruit stem 3-4 mm. thick; pistil end rounded with pistil scar at center, sometimes with very light ring mark surrounding the scar; longitudinal diameter 5.6 to 5.8 cm. or longer, latitudinal diameter 6.2 to 6.5 cm. or wider; rind thin, 3 to 5 mm. thick, very smooth, yellowish orange at maturity; oil cells very fine, projecting; pith about 9 mm. at broadest part, solid; sections 10-11, tightly adhering to each other; flesh very light orange at maturity, very juicy, finely grained, pulp vesicles sour-bitter taste; seeds many, small, rather thick, 11 to 15 mm. long, 6 to 8 mm. at the thickest part; outer skin creamy white, inner skin light reddish pink; embryo white.

This variety is represented by the specimen Ben 244, collected by the author from Tai-tung Village, Honan Island, growing along a stream where the tide water reaches. It seems adapted to a moist condition and for this reason it has a great possibility for stock in the grafting of other citrus forms when they are to be planted in this condition. It differs from the *Fu-tau Ch'ang* in the smoothness of the rind of the fruit and its narrowly elliptical leaves.

3. TOI-TOI KWOH. Fig. 3.

A spineless tree, or sometimes with a few short spines. Leaves elliptical ovate, petioles broadly winged like those of the *Fu-tau Ch'ang*. Fruit globose, with very thick persistent calyx; rind dark orange when ripe; pulp vesicles juicy, sour-bitter taste; seeds usually few and of medium size resembling those of the *Fu-tau Ch'ang*.

Toi-toi means generation after generation. As it is significant to the Chinese people, this fruit is usually used in connection with their worship during the Chinese New Year's festival; hence, it is mostly grown as an ornamental.

4. LUNG-TAAM TAI CH'ANG. Fig. 4.

A tree usually without spines (sometimes with short spines), many-branched, lower branches drooping; young shoots light green, becoming brownish when they are older. Leaves of terminal or fruiting branches oval to elliptical ovate; blade 7 cm. or less to 11 cm. or more long, 3.5 to 6.5 cm. or more at the broadest part; petiole from almost linear to more or less broadly winged, 15 to 25 mm. or more long, 2 to 10 mm. or more at the broadest part; apex bluntly pointed, rounded, or slightly indented; margin shallowly crenate. Fruit usually subglobose or more or less flattened; stem usually attached obliquely, about 6 mm. or more thick; calyx end rounded or slightly depressed, the calyx narrowly or inconspicuously lobed; pistil end rounded or very slightly depressed, at the center of which is the pistil scar of about 3 mm. diameter; longitudinal diameter 7.5 cm. to 9 cm. or more, latitudinal diameter 8.5 to 10 cm. or more; rind slightly loose or tightly attached to the carpel, 5 to 8 mm. or more thick, yellowish orange at maturity, white inside, surface when magnified very uneven; oil cells small and projecting; pith about 15 mm. or more at the thickest part, usually solid; segments or sections usually 12 to 13, sometimes loosely attached to each other; pulp vesicles large and long, very juicy, sour with bitter taste; seeds many, large, rather thick or flat, striated in the same manner as the pummelo seed, 14 to 17 mm. or more long, 6 to 10 mm. or more at the widest part; outer skin creamy white, inner skin pinkish brown, purplish pink at the cover of the tip end; embryo white or sometimes light greenish white.

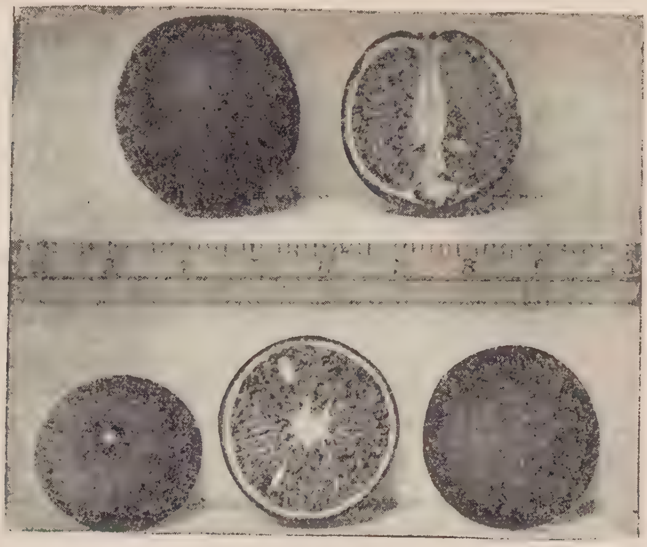

Fig. 7.—Luntau navel orange

This variety is represented by the specimen Ben. 240, collected by the author from Lung-taam Village, Honan Island. The fruit is exceptionally large for an orange and has a great resemblance to that of the grapefruit in size, but differs in having a light orange rind rather than a greenish or greenish yellow one. In the absence of grapefruit, it may serve as a substitute. Seedlings grown from the seeds of this variety show vigor in their growth and, hence, may be useful for stock purposes.

5. TAI SUEN CH'ANG, OR TAI KOM. Fig. 5.

An upright tree, reaching to a height of over 5 meters, usually with few spines. Leaves at terminal or fruiting branches usually elliptical ovate; margin coarsely crenate; petiole slightly to broadly winged. Fruit usually subglobose with tip broader than base end; calyx end rounded; pistil end very lightly depressed or rounded, sometimes with pistil mark (about 2 mm. diam.) projecting; longitudinal diameter to about 7.3 cm. or more, latitudinal diameter to about 9.5 cm. or more; rind yellowish orange at maturity, about 5 mm. or more thick, surface rather smooth; pith 11 mm. or more at thickest part, solid; sections or segments usually 11; flesh very light orange at maturity; pulp vesicles rather long and thick, very juicy, quite acid in taste; seeds few to many, about 14 mm. or more long, about 9 mm. or more at the thickest part, rather flat, shallowly striated; outer skin creamy white, inner one pinkish brown; embryo white.

This variety is represented by the specimen Ben 16 collected by the author from Szwui District. The seeds and texture of the skin are similar to the character of the *Kom* (mandarin orange), but the flesh adheres to the rind, and the embryo is white, similar to the tight-skin orange. It is most probable that it may be a hybrid of the orange and the mandarin orange. It has also a resemblance to that of the *Lung-taam Tai Ch'ang* in the form and size of the fruit.

6. SZWUI CHAU CH'ANG. Fig. 6.

A many-branched tree, reaching over 4 meters high. Leaves like the preceding variety but differ in having narrower petiole. Fruit subglobose, over 8 cm. diameter, with the tip usually broader than the base; calyx end rounded or slightly projecting; rind thick, tight, yellowish orange at maturity; pulp juicy, acid-bitter taste; seeds large, many, striated.

This variety is grown in sandy loam soil. From observation, it is more adapted to light soil condition than the other form of oranges in the region where it was collected. Hence, there is a great possibility in using this variety as stock for other forms of citrus. It is represented by the specimen Ben 231, collected by the author from Szwui District.

THE SWEET ORANGE

Citrus sinensis Osbeck, Dagbok Ostind. Reisa 41. 1757, nomen nudum, Reisa Ostind. China 250. 1765; Swingle in Sargent Pl. Wils. 2: 148. 1914.

Syn: *C. aurantium* (non Linn.) Lour. Fl. Cochinch. 466. 1790, ed. Willd. 569. 1793.

C. aurantium Linn. var. *sinensis* Linn. in Willd. Linn. Sp. Pl. 4th ed. III (Paris. II): 1426. 1800.

A tree with a compact, conical head, and regular branches; bark brown; spines when present slender, flexible, rather blunt. Leaves oval or ovate oblong, 7.5 to 10 cm. or more long, smooth, shiny, somewhat lighter below than above, more or less rounded at the base, distinctly tapering and pointed at apex; margin entire or very slightly crenate; petiole 1 to 2.5 cm. long, slightly winged, rarely broadly winged, articulated both with the twig and blade. Flowers perfect, axillary in clusters of 1 to 6, white, sweet-scented, smaller than *C. aurantium* Linn.; calyx cupped, lobes 4 to 5, awl-shaped, glabrous, thick, greenish, persistent; alabaster slender, petals white on both sides, usually five, oblong, 2 to 3 cm. long, thick, fleshy, recurved; stamens 20 to 25, hypogynous, filaments flattened, united in groups, shorter than the petals; pistil distinctly divided into stigma, style, and ovary; stigma knob-like, style long and slender, ovary rounded, 10-14 loculed. Fruit globose or slightly oblate, light orange to reddish orange, rind smooth; core solid; pulp juicy, highly aromatic, subacid, sweet to very sweet or honey-sweet in taste; segments 10 to 14, tightly adhering to each other; seeds few to many, sometimes none, oblong-ovoid, generally broad, wedged or pointed at the micropylar end, surface lightly striated.

The specific name *C. sinensis* refers to China, on account of its being introduced first from China.

Economic and commercial importance

As this fruit is widely known all over the world, it is needless to state in detail its importance. Because of its vitamin content and its invigorating effect upon the body, the orange is considered a family fruit. It is said that in America (U.S.A.) there is hardly a family that does not eat oranges every day. In proof of this, before the present century there was a common saying that an apple a day keeps the doctor away, but now this is applied to the orange and we may say: "An orange a day keeps the doctor away". As a matter of fact, the orange is prescribed by doctors in the diet of patients.

Key to the varieties and strains of the sweet oranges

A. Fruits usually with navel mark.
  B. Fruit with very conspicuous navel mark, oval form, projecting at apex. —*1. Luntau Navel Orange.*
  B. Fruit with navel mark not very conspicuous, subglobose or somewhat globose, pistil end rounded.
    C. Taste of fruit sweet, without acidity —*2. Hushuae Orange.*
    C. Taste of fruit acid —*3. Hoi-chow Navel Orange.*

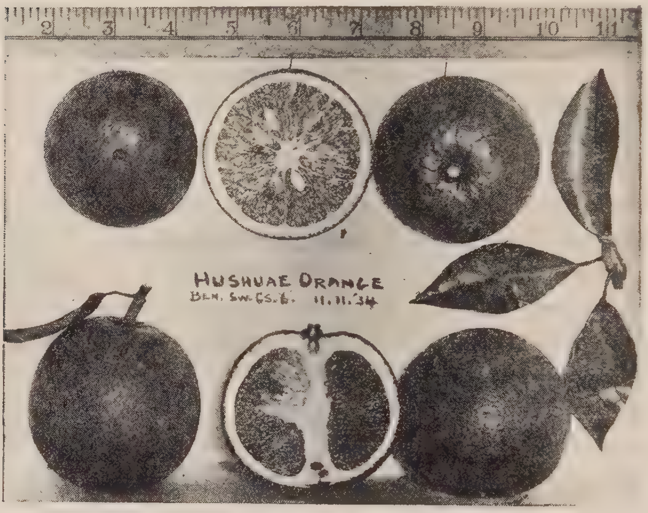

Fig. 8.—Hushuae orange

A. Fruits without navel mark.
  B. Fruit with corrugations.
    C. Deeply corrugated, corrugation almost reaching the apex of fruit —*4. Ming Lau Ch'ang.*
  B. Fruit without corrugations.
    C. Fruit sweet (even unripe) to very sweet or honey-sweet, without acidity —*6. Om Lau Ch'ang.*
      D. Skin glossy, more intensely sweet in taste *6-a. Hoi-chow T'im Ch'ang.*
      D. Skin not glossy, not as intensely sweet as *6-a* *6-b. Sunwui T'im Ch'ang.*

C. Fruit with acidulous sweet taste.
  D. Size of fruit very large, not less than 7 cm. longitudinal diam., 7.4 to 8.8 cm. or more latitudinal diameter—*7. Szwui Ch'ang.*
  D. Size of fruit small to large, longitudinal diam. 5.5 to 6.6 cm. or more, latitudinal diam. 6 to 7.3 cm.—*8. Heung Shui Ch'ang.*
    E. Fruit usually oblate or flattened, both ends depressed—*8-a. Pin-sun Ch'ang.*
    E. Fruit globose, subglobose or ball-like form.
      F. Pulp very juicy; seeds few, fruit large with rather thick rind—*8-b. Mariae Orange.*
      F. Juice rather scanty; seeds usually none or very few; fruit small to medium; rind rather thin—*8-c. Lan-fa Ip Ch'ang.*

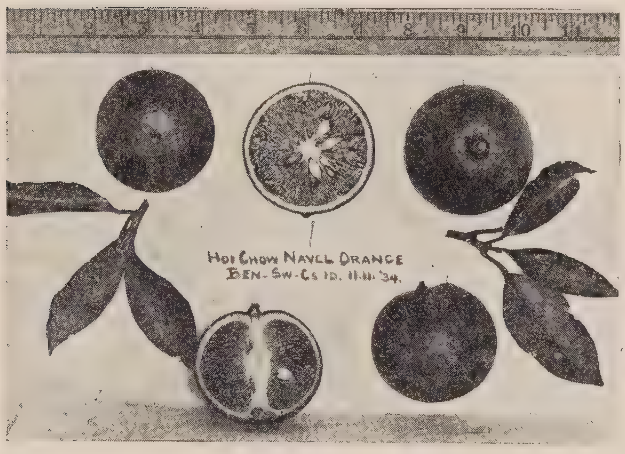

Fig. 9.—Hoichow navel orange

1. LUNTAU NAVEL ORANGE. Fig. 7.

A tree with low spreading branches. Leaves at the end of fruiting or terminal branches elliptical, 6.5 to 11 cm. long, 3 to 6 cm. at the widest part, with both ends more or less acuminate, apex somewhat indented. Fruits oval or globose; pistil end rather projecting with conspicuous navel mark at the center of which is a hole of about 3 to 5 mm. diameter; stem or calyx end slightly depressed; rind orange-red outside, white inside, tight, adhering closely to the flesh, about 5 mm. thick, oil cells small, projecting; longitudinal diameter 7 cm. or more, latitudinal diameter 6.6 cm. or more; pith solid, about 10 mm. at thickest part; segments 10 to 12, closely adhering to each other; flesh yellowish orange, finely grained, juicy, taste very sweet; seeds few, about 18 mm. long, 6 mm. thickest part; outside shell creamy white, slightly striated, inner skin pinkish brown; embryo white.

This variety is represented by the specimen Ben 99, collected by the author from Luntau Village at the east end of Honan Island near Whampao. It is characterized by its conspicuous navel mark at the pistil of the fruit. It is called *Luntau Navel Orange* in honor of the village where it is grown. When this is carefully selected, it may become one of the finest oranges of Kwangtung.

2. HUSHUAE ORANGE. Fig. 8.

A tree with low spreading or drooping branches. Leaves elliptical, those at the terminal or fruiting branches 7.5 cm. or more long, 3 cm. or more at broadest part, both ends broadly or narrowly acuminate, sometimes with indented apex; petioles to about 1.2 cm. or more long, very narrowly winged or slightly so. Fruit almost globose, wider than long; longitudinal diameter 7 cm. or more, latitudinal diameter 7.5 cm. or more; pistil end rounded to slightly projecting with conspicuous navel mark at the center of which is a small hole, the navel mark in this case is not as large as the *Luntau* orange; the stem or calyx end slightly depressed; rind about 6 mm. thick, adhering tightly to the carpel; pith or core solid, about 9 mm. thickest part; segments usually 13, adhering closely to each other; flesh light orange, juicy, sweet in taste; seeds few with the character of the *Luntau* navel orange.

This is represented by the specimen Ben Sw. C.S.6, collected by the author from Hoichow Village, Chungpshan District. It differs from the preceding form in its smaller size of navel mark, and more globose form.

3. HOICHOW NAVEL ORANGE. Fig. 9.

A tree with low spreading branches. Leaves at the end of the fruiting or terminal branches elliptical, more or less acuminate, sometimes indented at the apex, 6.5 to 8.8 cm. long, 2 to 4 cm. wide; petiole narrowly winged or slightly so. Fruit globose or subglobose, usually oblique; pistil end rounded or very slightly projecting, the navel mark small, not so conspicuous as that of the *Hushuae* and *Luntau* oranges; calyx end slightly depressed, wider than long; longitudinal diameter usually 5.5 to 6 cm., latitudinal diameter 6 to 7 cm.; core usually 10 to 12 mm. at the thickest part, sometimes less; segments 12 to 14, sometimes less; flesh light orange in color, very juicy, sweet blended with acid taste; seeds sometimes many, large, and rather short and plump; embryo white.

This orange is represented by the specimen Ben Sw.C.S. Nos. 7 to 13, all collected by the author from the small Island of Lung Lin Sha, Hoichow Village, Chung-shan District. It is characterized by its sweet-acid taste of pulp as compared with the *Luntau* and *Hushuae* oranges which are more intensely sweet in taste. It is named "Hoichow Navel Orange" in honor of Hoichow Village.

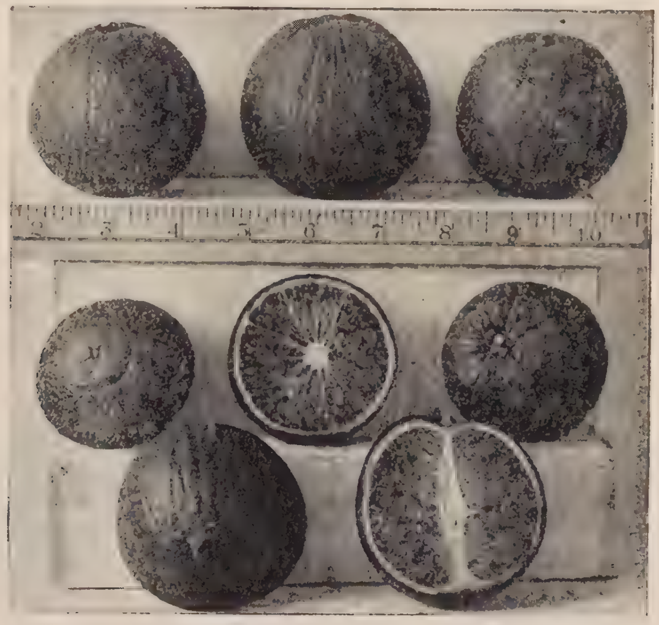

Fig. 10.—Ming Lau Ch'ang

4. MING LAU CH'ANG. Fig. 10.

A tree with almost spineless branches. Leaves at the fruiting or terminal branches oval to elliptical, 8 to 12 cm. or more long, 4 to 7 cm. or more wide; petiole narrowly winged. Fruit sub-oval or globose; longitudinal diameter 5.8 to 7 cm. or more, latitudinal diameter 5.6 to 6.9 cm. or more; pistil end usually rounded, some with a ring mark surrounding the pistil scar; calyx end slightly depressed with stem usually obliquely attached to the fruit; rind 4 to 5 mm. thick, reddish orange outside when well matured, white inside, deeply or prominently corrugated from the stem attachment almost to the apex; oil cells small, not prominent; pith or core 6 to 10 mm. at the thickest part, solid; sections 10 to 12, adhering to each other; flesh yellowish orange at maturity with light yellowish orange juice, taste sweet to very sweet, sometimes tasteless; seeds few or almost none, sometimes many and large, 16 to 17 mm. long, 6 to 7 mm. thickest part, very slightly striated; outer skin creamy white, inner skin pinkish brown; embryo white.

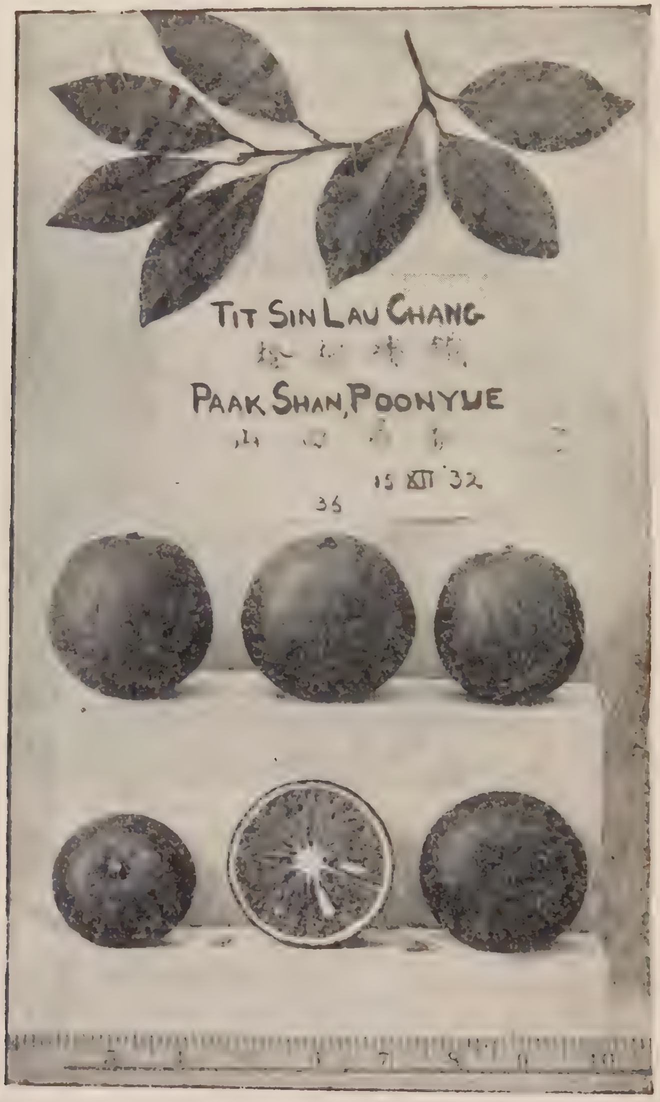
TIT SIN LAU CHANG
PAAK SHAN, POONYUE
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Fig. 11.—Tit-sin Lau Ch'ang

This orange is represented by the specimens Ben 66 and 75, the former from Tung Kaap and the latter from Ngoy-hoy, both of Sunwui District; Ben 2 from Szwui District; Ben 28 from Lip-taak, P'an-yu District; Ben 47 and Ben Sw.C.S.15, both from Lun Lin Sha, Chung-shan District; Ben 51 from Hoichow, Chung-shan and Ben 60 from Kutchan, Chung-shan District. All these specimens were collected by the author. The variety name, *Ming Lau Ch'ang,* is used so as to retain the common name which is well known among the fruit growers and dealers.

5. TIT-SIN LAU CH'ANG. Fig. 11.

A tree usually with spines but not as large as those of the sour orange. Leaves of the fruiting and terminal branches oval to elliptical, more or less pointed at both ends, 7.5 to 8.5 cm. or more long, 4 to 4.8 cm. or more at the widest part; petiole linear or wingless or slightly winged. Fruit globose, oval or oblate; longitudinal diameter 5.8 to 6.4 cm. or more, latitudinal diameter 6.3 to 7.6 cm. or more; pistil end rounded or slightly depressed, sometimes the pistil scar is surrounded with a ring of about 2 cm. diameter; calyx end slightly depressed at stem attachment; rind 4 to 5.5 mm. thick, orange-red outside at maturity, snow-white inside, corrugation not well defined as that of the *Ming Lau Ch'ang,* reaching only about half-way or a little over between the base and pistil ends; oil cells fine, close to each other, projecting; pith 9 to 11 mm. at the thickest part, solid; sections or segments 11 to 13, closely adhering to each other; flesh light yellow orange to orange at maturity; juice very light orange, moderately abundant, sweet to intensely sweet, generally sweeter than the *Ming Lau Ch'ang;* seeds few or seedless, usually small and elongated, 15 mm. or more long, 6 to 7 mm. thick, very shallowly striated, pointed at attachment end and rounded at the tip; outer skin creamy white, inner skin pinkish brown; white embryo.

This orange is represented by the specimens Ben 27 and 36, both from Paak Shan, Honan Island, Ben 19 from Lokongtung, and Ben 27 from Lip Taak, all of P'an-yu District; collected by the author. The name *Tit-sin Lau Ch'ang* is used in order to retain the local name.

6. OM LAU CH'ANG. Fig. 12.

A tree with low spreading branches, almost without spines. Leaves at the terminal and fruiting branches oval-elliptic with ends gradually pointed but tip rather blunt, rounded, or indented, shallowly crenate, 7 to 11 cm. or more long, 3 to 5.8 cm. or more wide; petiole 1.2 to 2 cm. long, almost wingless to narrowly winged. Fruit oval, globose or oblate; pistil end rounded or flattened, usually the pistil scar is surrounded with ring mark of about 2 mm. diameter; calyx end flat or slightly depressed at stem attachment; longitudinal diameter 6 cm. or more, latitudinal diameter 6 to 7 cm. or more; rind usually 4 cm. or more thick, light orange to reddish orange at maturity, tightly attached to the carpel; oil cells very small, projecting; pith or core 8 to 10 mm. or more at the thickest part, solid; sections or segments 10 to 12; flesh usually finely grained, yellowish

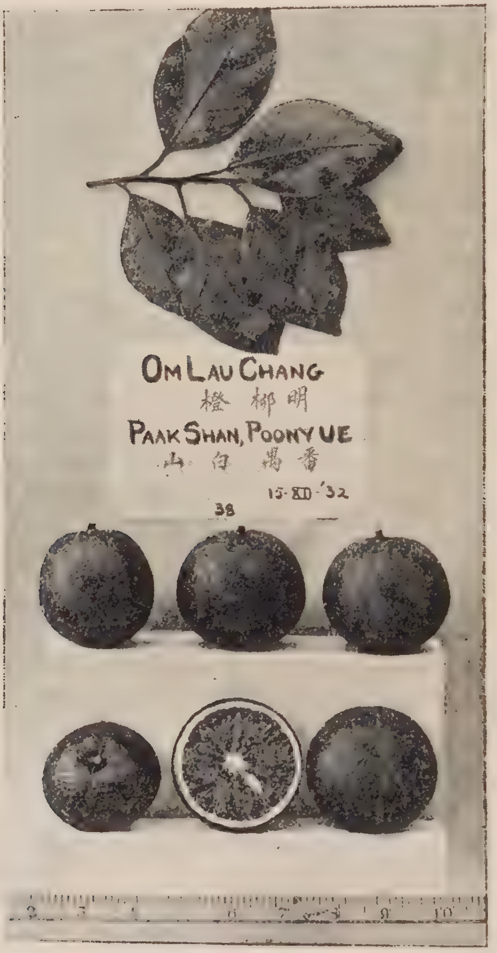

Fig. 12.—Om Lau Ch'ang

orange at maturity; juice abundant, light yellow orange, taste sweet to very sweet; seeds few to many, sometimes none, 14 to 18 mm. long, 6 to 7.5 mm. thickest part, very slightly striated, obovate, pointed at attachment, more or less rounded at apex; outer coat creamy white, inner coat purplish pink; embryo white.

The type specimens are Ben 38 and 39, both from Paak Shan, P'an-yu District. Other specimens are Ben 20 and 21 from Lokongtung, P'an-yu District, Ben 48 and 59 from Lung Lin Sha and Kutchan, both of Chung-shan District; all collected by the author. The name *Om Lau Ch'ang* is used in order to retain its common name, being well known among the fruit growers and dealers.

There are two strains of this variety, namely, *Sunwui T'im Ch'ang* and *Hoichow T'im Ch'ang;* both are supposed to be the best oranges of Kwangtung Province. Tanaka (1928) considers that the *Sunwui T'im Ch'ang* is the best sweet orange of the world in quality, but according to investigations made by the author, the *Hoichow T'im Ch'ang* is even superior in quality.

6-a. SUNWUI T'IM CH'ANG. Fig. 13.

Fruit globose, oval or oblate; pistil end rounded, some with ring mark surrounding the pistil scar; calyx end slightly depressed; longitudinal diameter 6 to 6.5 cm. or more, latitudinal diameter 6 to 7 cm. or more; rind 4 to 4.5 cm. or more thick, orange to reddish orange at maturity, white inside; oil cells small, close to each other; pith 8 to 10 mm. at the thickest part, solid; sections 10 to 12, closely adhering to each other; flesh yellowish orange, juice abundant, light yellow orange, taste sweet to intensely sweet, seeds few or none, 15 to 18 mm. long, 5 to 7 mm. thickest part, slightly striated; outer skin creamy white, inner coat purplish pink; embryo white.

The type specimens are Ben 79 and 74, both from Ngoy-hoy, Sunwui District, collected by the author. Another specimen is Ben 65 from Tung Kaap, Sunwui, also collected by the author. It is claimed by practically all the citrus producers and merchants that Tung Kaap is the home of the best *Sunwui T'im Ch'ang* of Kwangtung, but contrary to this, it is strange to note that during the Citrus Exhibition held at Canton in January to February, 1933, the Exhibit No. 91 (Ben 65) from Tung Kaap, which the author collected and believed to be the best procurable from the locality, got no prize from the exhibits, while that from Ngoy-hoy, Exhibit No. 105 (Ben 79) was awarded the first prize. There was a specimen, Exhibit No. 92 (Ben 66), from Tung Kaap which got a second prize but it is classed under the *Ming Lau Ch'ang* variety. It may be said, therefore, that Ngoy-hoy produces a more superior quality of sweet orange fruit than that of Tung Kaap.

It may be noted here that the name *Sunwui T'im Ch'ang* is very misleading because what is generally considered by those unfamiliar with the citrus fruits as the *Sunwui T'im Ch'ang* is any orange from Sunwui, either the *Ming Lau Ch'ang* or the *Om Lau Ch'ang,* or sometimes the *Heung Shui Ch'ang* (a more acidulous fruit). It is inferred that the *Ming Lau Ch'ang, Om Lau Ch'ang,* and the *Heung Shui Ch'ang* are all of different forms of oranges. In this respect, the author considers that the true *Sunwui T'im Ch'ang* is represented by the *Om Lau Ch'ang* form of sweet orange, which possesses the characters above described.

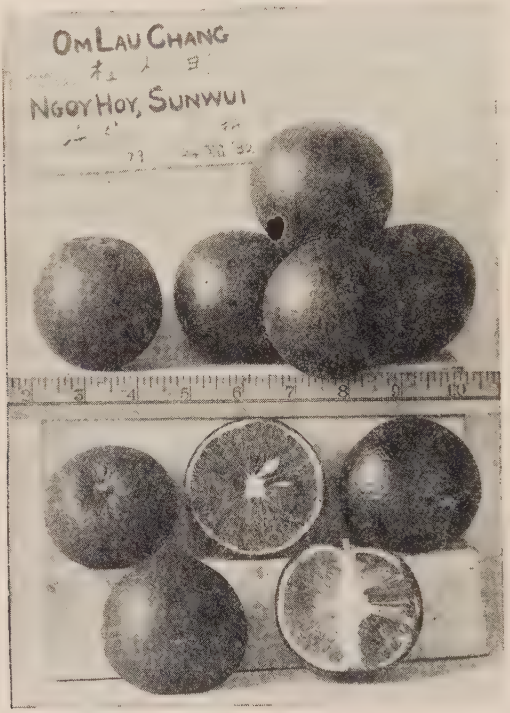

Fig. 13.—Sunwui T'im Ch'ang

Another point to be clarified is what makes the *Sunwui T'im Ch'ang* particularly sweet? The citrus growers of Sunwui believe that when this plant is grown in other parts of the country, the quality of the fruit will not be the same as that produced in Sunwui. Since it is an established fact that soil character has some direct influence upon the fruit or the leaves of plant, so it may also be true of the fruit of this orange. The author has noticed that if a coffee tree is planted in a reddish soil, the quality of the berries is superior to that planted in a dark soil, that is, the taste, flavor, or aroma of the coffee is very much stronger and superior than of that from the dark soil. If a tobacco plant is planted in heavy soil, the leaves are heavier and darker in color than those planted in light soil.

There is another point to be brought up, that is, the belief of the growers that when a tree is transplanted two or three times, the fruit from the last transplanting will be almost seedless as compared with that from an untransplanted tree, and also sweeter. As far as the author can ascertain, there are no established data about this, but according to observation, the older the tree, the more intensely sweet the fruits. Seedlessness is believed to be a matter of hereditary character, although sometimes the younger trees bear more seedy fruits than the old ones. Continuous vegetative propagation, that is, layering and inarching, which are the usual practices of the citrus growers of the district, has greatly altered the propagative character of the plant by causing it to lose its power of producing seed inasmuch as it was not used probably for centuries in this particular region as well as in other parts of the province.

6-b. HOICHOW T'IM CH'ANG. Fig. 14.

Fruit globose, oval or oblate; pistil end rounded with usually a ring mark surrounding the pistil scar; calyx end very slightly depressed; longitudinal diameter 6 to 6.5 cm. or more, latitudinal diameter 6 to 6.8 cm. or more; rind 4 to 4.5 mm. or more thick, reddish orange at maturity, white inside; pith about 8 mm. at the thickest part, solid; sections or segments with very thin partition; flesh yellowish orange; juice abundant, light yellow orange, taste sugar or honey sweet; seeds very few or none, 14 to 16 mm. long, about 6 mm. at thickest part, very slightly striated, pointed at attachment and rounded at the tip; outer coat creamy white, inner one purplish pink; embryo white.

The type specimens are Ben 53 (Exhibit 85) and Ben 52 (Exhibit 84), both collected by the author from Yuen Hon Peng Orchard in Hoichow Village, Chung-shan District. The main characteristic of this orange is its glossy, bright reddish orange skin when mature, and its honey-sweet taste. In the orchard, where these fruits were taken, there are about 50 trees bearing this kind of fruit.

It may be interesting to note here that during the citrus season (December) of 1932 when these fruits were collected for the coming citrus exhibition (January to February, 1933), after coming from Hoichow Village and other villages in Chung-shan District, I went to Sunwui District in search of the best *Sunwui T'im Ch'ang.* While in Kongmoon, the capital of the District, I consulted the magistrate at that time, and after explaining the object of my trip, which was the collection of citrus fruits for the coming exposition, he kindly assigned the district agricultural inspector to accompany me to the various citrus producing centers of Sunwui. So on December 22, 1932, we went to Tung Kaap, the village reputed to be the producer of the best *Sunwui T'im Ch'ang.* Upon arrival there, we inquired from the village elders where we could find the best *Sunwui T'im Ch'ang* in the region. They conducted us first to an orchard

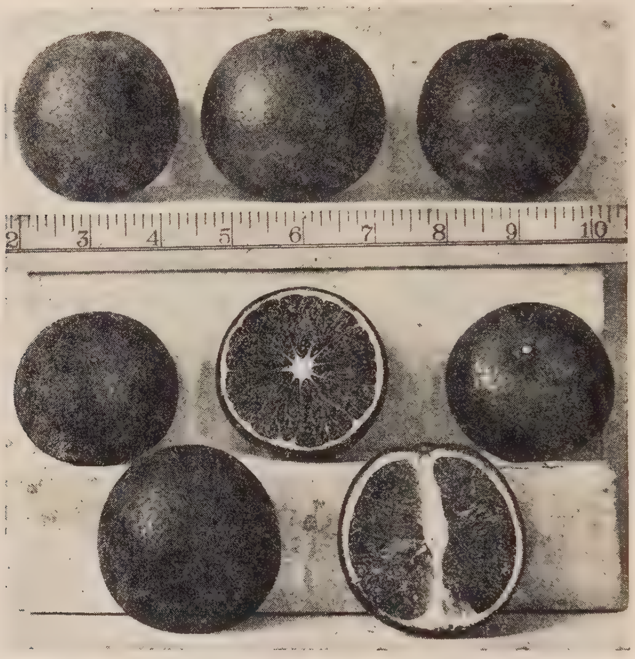

Fig. 14.—Hoichow T'im Ch'ang

which they claimed produced one of the best sweet oranges in the village, and afterward we went to several other orchards. Contrary to expectations, I could not find any fruit resembling that from Hoichow. The next day, December 23 we went to Lai-ngok, another citrus producing village, but still we could not find any fruit matching that from Hoichow. Then on December 24, we went to Ngoy-hoy, and from there I collected six specimens from six citrus trees, one *Ming Lau Ch'ang* (Ben 75), two *Heung Shui Ch'ang* (Ben 76), second prize in the exhibit, and Ben 78; one small loose-skin orange (Ben 77), and two *Om Lau Ch'ang* (Ben 74 and Ben 79). From Sunwui, only the last two specimens approached the quality of those from Hoichow. As a matter of fact, Ben 79 was awarded first prize in the exhibition. From the above data, it may be considered that the best *Sunwui T'im Ch'ang* is produced in Ngoy-hoy instead of Tung Kaap, and that the *Hoichow T'im Ch'ang* is superior in quality to the *Sunwui T'im Ch'ang*.

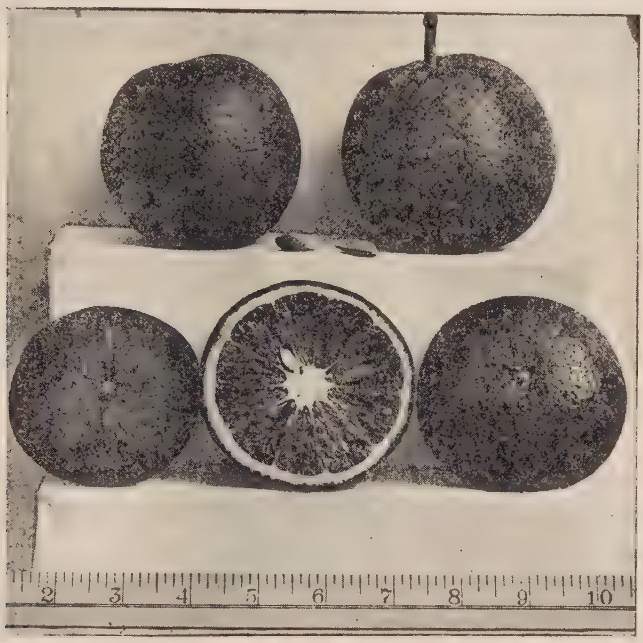

Fig. 15.—Szwui Ch'ang

7. SZWUI CH'ANG. Fig. 15.

An upright tree with few spines. Leaves at terminal and fruiting brances oval to elliptical ovate; petiole almost wingless to slightly broadly winged. Fruit subglobose, oval, somewhat flattened or round, usually obliquely attached to the stem; calyx end depressed, more or less prominently ridged; pistil end rounded, usually with a hole (about 3 mm. diam.) mark at the center; longitudinal diameter 7 to 7.7 cm. or more, latitudinal diameter 7.4 to 8.8 cm. or more; rind 4.5 to 5.5 mm. or more thick, rather rough, elastic, orange to reddish orange at maturity; oil cells small and projecting; pith about 16 mm. or more at thickest part, somewhat hollowed; sections or segments usually 11 or more, not very tightly attached to each other; flesh light orange to orange in color at maturity; pulp vesicles rather large and long, very juicy, sweet, blended with acid taste; seeds few to many, rather large, flat and thick, short or long, striated similar to the seed of pummelo, 14 to 22 mm. long, 7 to 9 mm. at the thickest part; outer coat creamy white, inner coat pinkish brown; embryo white.

This variety is represented by the specimens Ben 9 and 93, both collected by the author from Sunwui District. This variety is characterized by its large fruit and thick, elastic rind which is a quality for good storage. When properly cultivated and the fruit properly handled, it will compare favorably with the Valencia orange.

8. HEUNG SHUI CH'ANG. Fig. 16.

A tree with variable character, upright or drooping branches, usually with sharper and more spines than the *T'im Ch'ang* form. Leaves generally narrower and with more pointed tips than the *T'im Ch'ang;* petiole narrowly or inconspicuously winged, sometimes broadly winged. Fruit globose, subglobose, or flattened, generally oblique (one side is smaller than the other side); longitudinal diameter 5.5 to 6.6 cm. or more, latitudinal diameter 6 to 7.3 cm.; calyx end usually flattened with slight depression, sometimes very slightly ridged; pistil end usually rounded, sometimes flattened with usually indented pistil scar of about 2 mm. wide; rind 4 to 6 mm. thick, usually smooth, sometimes rather rough, orange to reddish orange in color at maturity, white inside, tightly attached to the carpel; oil cells usually small, close to each other and usually projecting; pith solid, 7 to 11 mm. at thickest part; sections 10 to 14, closely attached to each other; flesh yellowish orange or light orange, moderately juicy to very juicy, sweet blended with acid taste; seeds few to many, sometimes none, long or short, pointed at attachment, very slightly striated; outer skin yellowish cream or creamy white, inner skin purplish pink; embryo white.

This variety is represented by the following specimens: Ben 1 from Szwui District, Ben 46 and 61 from Hoichow and Kutchan, Chung-shan District, Ben 70, 76, and 78 from Tung Kaap, and Ngoy-hoy, Sunwui District, Ben 29, 30, and 34 all from Paak Shan, P'an-yu District; all collected by the author.

The name *Suen Ch'ang,* which is generally applied to the group of sweet orange with a sweet-acid taste, is very misleading because *Suen* means sour, and *Ch'ang* means orange. The true sour orange is sometimes also called *Suen Ch'ang,* although there is assigned special names such as *Toi-toi Kwoh, Tai Ch'ang, Chau Ch'ang,* etc. For this reason, the name *Heung Shui Ch'ang* is adopted in this paper for the sake of convenience and clearness and to distinguish this variety from the sweeter form, and also from the true sour orange. Three strains are considered in this paper under this variety, *Pin-sun Ch'ang, Mariae Orange,* and *Lan-fa Ip Ch'ang.*

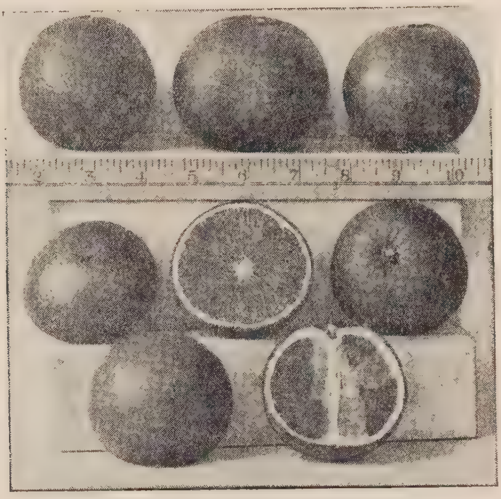

Fig. 16.—Heung Shui Ch'ang

8-a. PIN-SUN CH'ANG. Fig. 17.

Fruit usually oblate or flattened; calyx end flattened and depressed at the stem attachment, more or less prominently ridged;

pistil end flattened, usually depressed with a projecting or a circular mark at the pistil scar which is about 3 mm. diameter; longitudinal diameter usually very much shorter than the latitudinal; rind about 5 mm. thick, rather rough in texture, usually orange to dark orange at maturity; oil cells very small, projecting; core solid, about 10 mm. at thickest part; sections usually 10 to 11; flesh yellowish orange, very juicy, sweet-acid taste; seeds few, large, and thick, 14 × 10 mm. striated, pointed at attachment; embryo white.

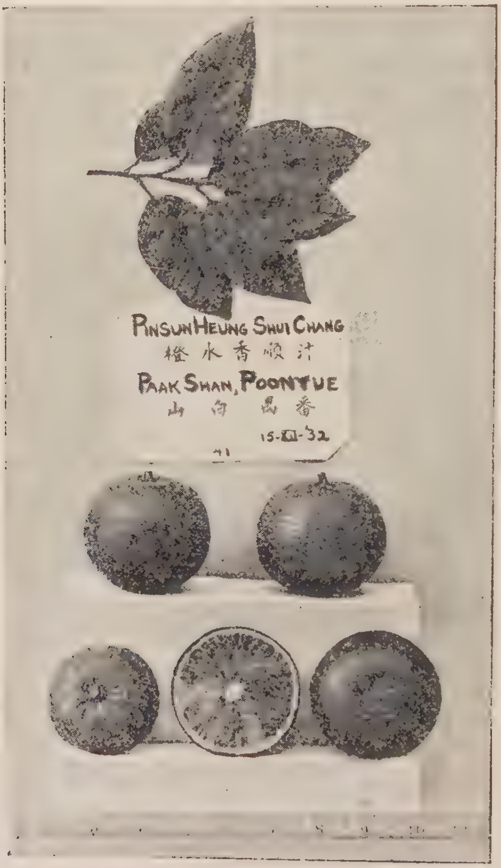

Fig. 17.—Pin-sun Ch'ang

This strain is characterized by its usually oblate form of fruit and large thick seeds. The type specimen is Ben 41 from Paak Shan, P'an-yu District collected by the author.

8-b. MARIAE ORANGE. Fig. 18.

Fruit usually globose or rounded with slightly depressed and slightly ridged stem attachment; pistil end round; longitudinal diameter 6.5 cm. or more, latitudinal diameter 7 cm. or more; rind about 6 mm. or more thick, rather rough in texture, elastic, dark orange in color at maturity; oil cells small, projecting; core solid, about 11 mm. or less at thickest part; sections usually 10; flesh very juicy, sweet, blended with acid taste; seeds few, large, and rather thick, 16 × 8 mm., slightly striated; embryo white.

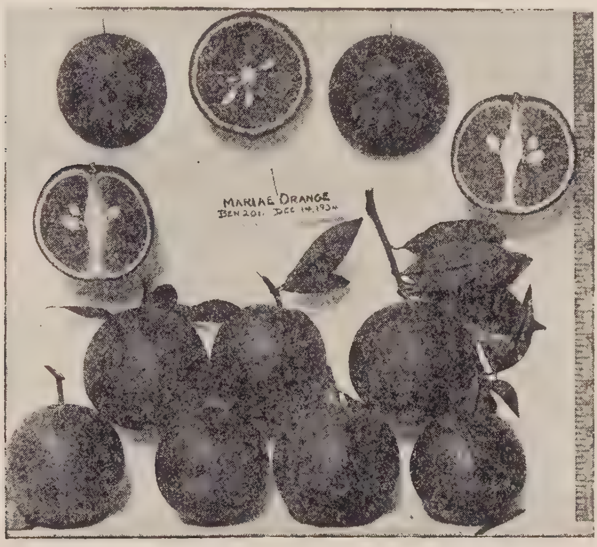

Fig. 18.—Mariae orange

This strain is characterized by its large globose or ball-like fruit with abundant juice. It is represented by Ben 201, collected by the author from Kutshan Village, P'an-yu District, where it is extensively cultivated. It is more adapted to sandy and low fields than other forms of oranges grown in the locality, and, hence, constitutes the larger portion of production. When this strain is improved, properly cultivated, and the fruit cured well, it is a very promising form of sweet orange in this region. The name *Mariae* is used for this in honor of Miss Mary Wong, a former student of Lingnan University.

8-c. LAN-FA IP CH'ANG. Fig. 19.

A more or less upright tree, almost spineless. Leaves of terminal and fruiting branches oval or elliptical ovate; blade 6 to 11 cm. or more long, 3.5 to 6 cm. or more at widest part, tip gradually narrowed with blunt and usually indented end; margin shallowly or irregularly andulate shallowly crenate; petiole almost wingless to prominently winged, 10 to 20 mm. or more long, 2 to 4 mm. or more at the broadest part. Fruit subglobose or ball-like form; calyx end rounded with slight depression at the stem attachment, stem 4-5 mm. thick; pistil end rounded or somewhat flat with a pistil scar sometimes

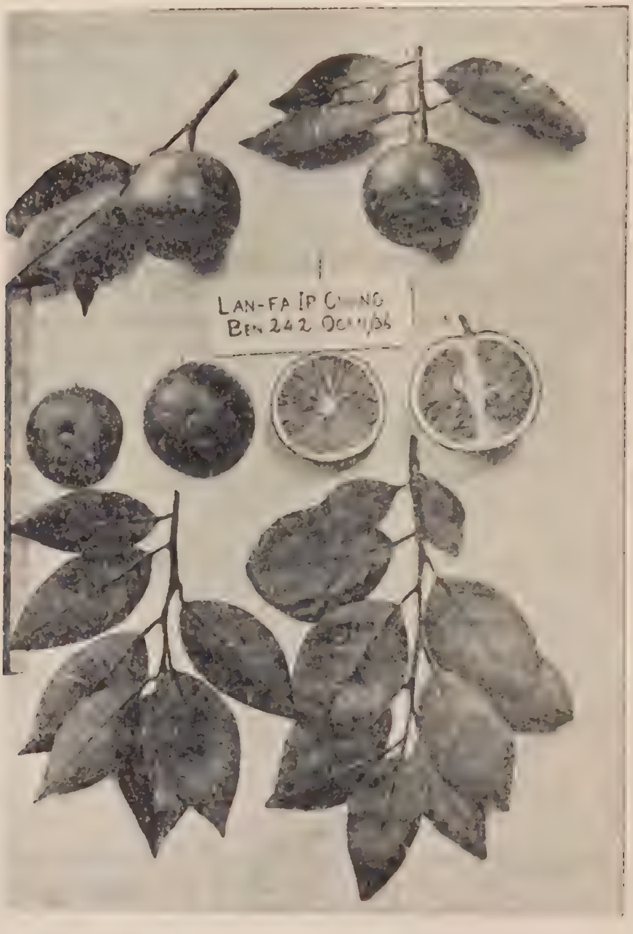

Fig. 19.—Lan-fa Ip Ch'ang

surrounded with a ring mark; longitudinal diameter 5.5 to 6.4 cm. or more, latitudinal diameter 6 to 7 cm. or more; rind thin, 4-5 mm. thick, orange to deep orange when mature; oil cells very fine, prominently projecting; pith solid 8 to 9 mm. or more at the thickest part; sections usually 11, very tightly attached to each other; flesh light orange at maturity, pulp vesicles very finely grained, moderately juicy or sometimes with scanty juice, sweet, blended with very light acidity; seeds very few or none, short, very finely striated; outer skin cream white, inner skin purplish pink; embryo very light greenish white.

This strain is represented by the specimen Ben 242 collected by the author from Lung Taam, Honan Islands, P'an-yu District. As it is adaptable to a low, moist condition, the citrus growers in this region prefer to grow it to other ranges. It is, therefore, advisable to grow this form in regions where the conditions are similar to the locality described. The term *Lan-fa Ip Ch'ang* is adopted in this paper in order to retain the common name used by the citrus growers.

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COLLEGE AND ALUMNI NOTES

Dean B. M. Gonzalez was appointed member of the National Economic Council by the President of the Philippines, the term to continue as long as he is Dean of the College of Agriculture.

Dr. L. B. Uichanco, head of the Department of Entomology, left on July 12, as delegate of the Philippine Commonwealth of the International Entomological Congress in Berlin, Germany, and to the International Locust Congress in Brussels, Belgium.

Dr. G. O. Ocfemia, Associate Professor of Plant Pathology, has been designated acting managing editor of *The Philippine Agriculturist* by the Dean of the College during the absence of Dr. L. B. Uichanco.

Dr. Francisco O. Santos, head of the Department of Agricultural Chemistry, was elected chairman of the section on nutrition of the National Research Council.

Papers read at the one hundred and thirty-second scientific meeting of the Los Baños Biological Club held in the lecture hall of the Agricultural Botany Building on July 28:

Dr. V. Villegas. The livestock industries of Cochin China, Cambodia, Siam, and Malaya.

Prof. Calixto Mabesa. The relation of green weight of bark of Bakawan and Pototan to their wood volume.

Mr. Phanom Smitananda, '35, is with the newly established junior college of agriculture in Xiengmai, Siam. He and a party of other Siamese alumni met Dr. Villegas in Bangkok when the latter visited Siam recently.

On the roster of the College for the first semester, 1938-39, are 145 freshmen, 143 sophomores, 72 juniors, 91 seniors, three candidates for the Certificate in Agricultural Education, two post-graduate students, and six special students.

Mr. L. G. Medrano, '39, is with Hacienda Rosario Poultry Farm, Bacolod, Occidental Negros, as poultryman.

COMPARATIVE EFFICIENCY OF PASTURE MANAGEMENT METHODS[1]

MIGUEL MANRESA, NARCISO N. PEPITO, AND ABEL L. SILVA
Of the Department of Animal Husbandry

WITH THREE TEXT FIGURES

In the past pasture lands in the Philippines were abundant and the number of live stock was relatively small; so live stock raisers paid little or no attention whatsoever to the problem of pasture management. The growing utilization of pasture lands for agricultural purposes, together with the steady increase of animal population in the Islands, has made the problem of pasture management urgent. In an eminently cattle producing province in Mindanao, large areas of pasture lands have already been rendered barren of vegetation or turned into weeds. Unless something is done to these pastures, beef production as an industry is bound to disappear in that province.

While climatic conditions and soil type modify to a greater or less extent the carrying capacity of pastures, the methods of management exert a great deal of influence. Heretofore, the only method of improving pastures in the Philippines has been that of burning large areas of cogon lands regularly every year. In a few ranches, some pasture lots are gone over by a crew of laborers who cut down the weeds and shrubs at irregular intervals; in others, the shrubs are grubbed, or uprooted. It seems important, therefore, to determine which of these three methods or which combination of these methods gives the best result from the point of view of securing the highest amount of animal feed and getting rid of the non-pasture plants, or weeds.

Review of literature

Griffiths (1907) states that burning is practical and productive in some pastures but destructive in others. Pastures of brome hedges (*Andropogon* sp.) are improved by burning while pastures of gramas (*Boutelma* sp.) are injured by it. To the general open range country, however, burning has no application because the

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[1] Experiment Station contribution No. 1248. Received for publication July 2. 1938.

vegetation of such a range is generally mixed, and whereas burning favors some grasses, it injures others.

As an essential point in improving pastures, the prevention of overgrazing and too early pasturing was suggested by Cotton (1908, 1910). Later on fertilization, cultivation, reseeding of the land, and eradication of the weeds have to be resorted to. This view is supported by Jardine (1915), who found in western pastures of the United States that over-stocking and premature grazing were the most direct causes of deterioration of pasture grasses. Improper handling of live stock, though less important than over-stocking and premature grazing, often brings about a marked reduction in carrying capacity.

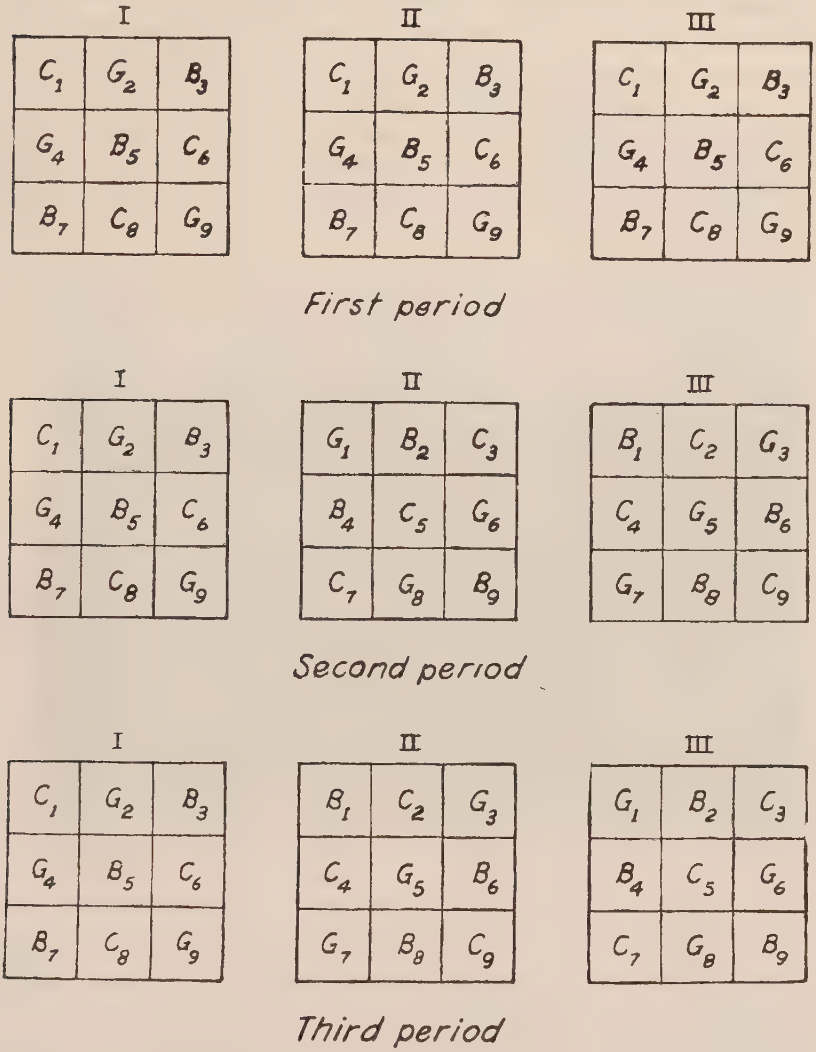
Hensel (1923) reported to have found that burning did not decrease the total number of grasses as is thought to be the case. It, however, caused a change in the composition of the grass type. Increase in soil temperature incident to burning was given as the cause of enhancing earlier growth of grasses when the old vegetation had been removed.

According to Schuster (1930), the average carrying capacity of pastures may be increased considerably by the addition of lime to the soil, as this induces the highest yield of grass and at the same time suppresses weed growth. Fertilization, especially with minerals, of pastures whose carrying capacity is less than one steer to the acre (approximately two-fifths of a hectare) is suggested by Crampton and Raymond (1934).

MATERIALS AND METHODS

As level land as could be found in the pastures of the Department of Animal Husbandry, College of Agriculture, was selected. The land covered an area of 1,200 square meters, 60 meters by 20 meters. The stand of vegetation was fairly even and typical of the College of Agriculture pastures as to variety and distribution of grasses and weeds. The different kinds of pasture grasses contained therein were sabung-sabuñgan, *Panicum flavidum* Retz.; culape, laau-laau, *Paspalum conjugatum* Berg.; bakis-bakisan, *Eleusine indica* (Linn.) Gaertn.; banigusa, kaliraurau, *Eragrostis viscosa* (Retz.) Trin.; alikbañgon, *Cyanotis* sp.; *Cynodon arcuatus* Presl; muthá, *Cyperus rotundus* Linn.; cogon, *Imperata cylindrica* (Linn.) Beauv. var. *koenigii* (Retz.) Benth.; agiñgai lalake, *Rottboellia exaltata* Linn. f.; and talahib, *Saccharum spontaneum* Linn. subsp. *indicum* Hack.

Weeds,[2] such as, dilang-aso, *Elephantopus spicatus* Aubl.; guava, *Psidium guajava* Linn.; takip-kohol, *Centella asiatica* (Linn.) Urban; eskoba, *Sida retusa* Linn.; dayang, *Cyathula prostrata* (Linn.) Blm.; balatong-aso, *Cassia tora* Linn.; sampasampalukan, *Phyllanthus niruri* Linn.; sili, *Capsicum frutescens* Linn.; mangkit, *Desmo-*



I			II			III		
C_1	G_2	B_3	C_1	G_2	B_3	C_1	G_2	B_3
G_4	B_5	C_6	G_4	B_5	C_6	G_4	B_5	C_6
B_7	C_8	G_9	B_7	C_8	G_9	B_7	C_8	G_9

First period

I			II			III		
C_1	G_2	B_3	G_1	B_2	C_3	B_1	C_2	G_3
G_4	B_5	C_6	B_4	C_5	G_6	C_4	G_5	B_6
B_7	C_8	G_9	C_7	G_8	B_9	G_7	B_8	C_9

Second period

I			II			III		
C_1	G_2	B_3	B_1	C_2	G_3	G_1	B_2	C_3
G_4	B_5	C_6	C_4	G_5	B_6	B_4	C_5	G_6
B_7	C_8	G_9	G_7	B_8	C_9	C_7	G_8	B_9

Third period

Fig. 1.—The layout of the experimental plots. C stands for cutting, B for burning, and G for grubbing

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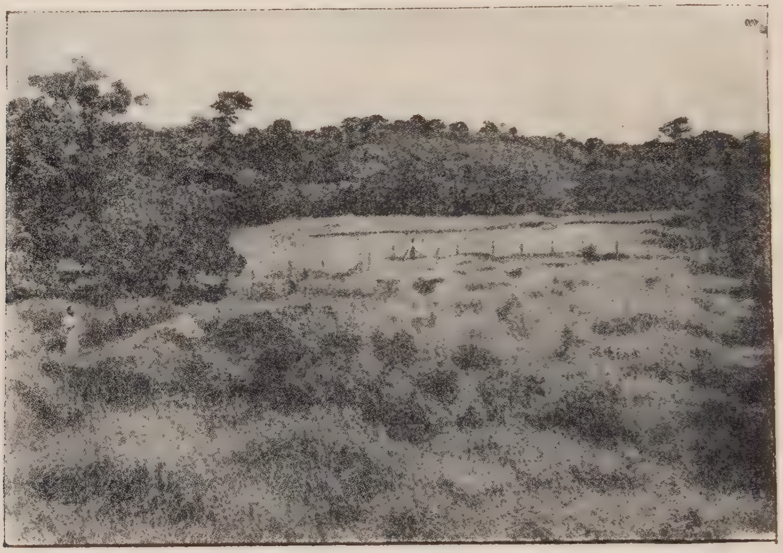
[1] Weeds in this paper include plants other than the grasses, which, although in some cases they are edible, yet affect the growth and stand of the grass.

dium gangeticum (Linn.) DC.; puñgapung, *Amorphophallus campanulatus* (Roxb.) Blm.; makahia, *Mimosa pudica* Linn.; palis, *Callicarpa cana* Linn.; payang-payang, *Flemingia strobilifera* (Linn.) R. Br.; aroma, *Acacia farnesiana* (Linn.) Willd.; isis, *Ficus ulmifolia* Lam.; saluyot, *Corchorus acutangulus* Lam.; kampupot, pandakaki, *Tabernaemontana pandacaqui* Poir.; bulak-manok, *Vernonia patula* (Dry.) Merr.; sambong, *Blumea balsamifera* (Linn.) DC.; sili-silihan, *Synedrella nodiflora* (Linn.) Gaertn.; balagun, mani-manian, *Teramnus labialis* (Linn. f.) Spreng.; kabilan, *Columella trifolia* (Linn.) Merr.; magilik, *Premna cumingiana* Schauer; banató, *Mallotus philippensis* (Lam.) Muell.-Arg.; anonang, *Cordia dichotoma* Forst. f.; hauili, *Ficus hauili* Blanco; tugli, *Derris elliptica* (Roxb.) Benth.; kulutkulutan, *Triumfetta* sp.; and kanlong, *Blumea laciniata* (Roxb.) DC., were also present. The plants unknown to the authors were identified by Dr. José B. Juliano, of the Department of Agricultural Botany. The common names were checked with the use of Merrill's *An enumeration of Philippine flowering plants* (1923-1926).

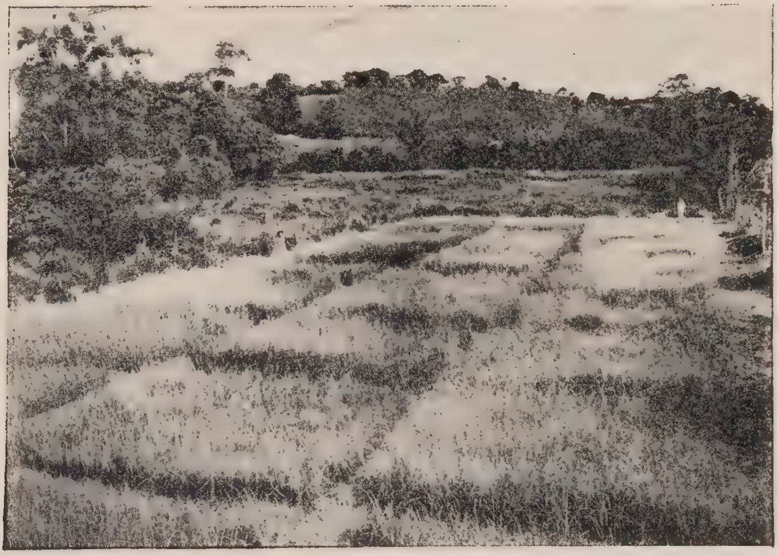


Photographic Division

Fig. 2.—The experimental plot at the beginning of the experiment after the sub-lots have been laid out. Photographed in April, 1934.

The experimental lot was enclosed completely with a barbed wire fence and divided into three main lots of 20 meters square each. Each of these three lots was again sub-divided into nine small sub-lots, 5 meters square. All the lots and the sub-lots were separated by paths one meter in width. The whole experimental area, therefore, was finally divided into 27 small sub-lots of 25 square meters each. The layout of the experiment is shown in the diagram (fig. 1). These sub-lots were numbered as follows: I-1, I-2, I-3, to I-9; II-1, to II-9; III-1 to III-9.

The lots were given their respective treatments in a definite cycle as shown in the diagram. Single treatments in this study mean that the sub-lots receive the same treatment continually period after period. Thus, some sub-lots were burned continually, others were cut continually, and still others were grubbed continually period after period. Thus, for the first, second, and third periods, sub-lot I-3, I-5, and I-7 were burned; lots I-1, I-6, and I-8 were cut; and sub-lots I-2, I-4, and I-9 were grubbed. The same treatments were given the sub-lots of II and III. In the second period sub-lots II-1, II-6, and II-8 were grubbed; sub-lots II-2, II-4, and II-9 were burned; II-3, II-5, and II-7 were cut; sub-lots III-1, III-6, and III-8 were burned; sub-lots III-2, III-4, and III-9 were cut and sub-lots III-3; III-5, and III-7 were grubbed. In the third period sub-lots II-1, II-6, and II-8 were burned; sub-lots II-2, II-4, and II-9 were cut; sub-lots II-3, II-5, and II-7 were grubbed. The sub-lots III-1



Photographic Division

Fig. 3.—The experimental plot before the harvesting of the third period harvest in August, 1935

and III-6 were grubbed; sub-lots III-2, III-4, and III-9 were burned; and sub-lots III-3, III-5, and III-7 were cut.

Harvesting was three months after treatment. In case of the sub-lots II and III, the pasture grasses were cut first, and the weeds were either grubbed out or cut. This method of harvesting was followed for sub-lots I-1, I-2, I-4, I-6, I-8, and I-9. The pasture grasses and weeds were weighed in a Fairbanks portable balance, and the weights recorded. When the grasses had dried in the sun they were weighed again to get the dry weight. For sub-lots I-3, I-5, and I-7, however, only the pasture grasses were cut; the weeds were left unmolested. For the other lots (II and III) that were to be burned, the sun-dried grasses were spread evenly to be burned later. A quadrat with an area of one square meter located in the center of each sub-lot was left unharvested. The pasture grasses and the weeds taken from these quadrats in the center of each sub-lot were classified as to species, counted and the results recorded. For the purpose of comparison, fresh and sun-dried weights were also taken and recorded.

DISCUSSION OF RESULTS

The single treatments

Pasture grasses. The data obtained in this experiment show that grubbing to remove the shrubs and weeds yielded the highest crop of pasture grasses. The removal of shrubs and weeds by cutting was second in yield and burning was the lowest in production. It may be seen in table 1 that during the first trial, when burning was compared with cutting, the difference in favor of cutting was 11.73 ± 8.88 kilograms. When burning was compared with grubbing, the difference in favor of grubbing was 18.72 ± 12.80 kilograms. When cutting was compared with grubbing, the difference in favor of grubbing was 6.99 ± 9.43 kilograms. This difference did not show significant advantage of one treatment over another during the first trial. The differences in the second and third trials, likewise, were not statistically significant.

It was noted, however, that grubbing consistently yielded a larger crop of pasture grasses than cutting, period after period, and cutting also consistently gave higher yield than burning, period after period. When the averages for the three trials were found, the yields were 43.96 kilograms for grubbing, 38.63 kilograms for cutting, and 32.97 kilograms for burning. On the basis of yields per hectare (see table 2), these differences are as follows: Cutting yielded 2,262.67 kilograms more than burning; grubbing, 4,394.67

kilograms more than burning; and grubbing, 2,132.00 kilograms more than cutting. From a practical standpoint, it may be stated, therefore, that there is a marked advantage of grubbing over cutting or burning and that cutting was better than burning.

The foregoing results were verified in later experiments wherein a much larger number of sub-lots were used so as to render the data so obtained amenable to statistical treatment. It may be seen in table 3 that during the first period of the experiment the total yield of pasture grasses of the different sub-lots under grubbing was 121.87 kilograms of fresh forage. The sub-lots under cutting yielded 118.50 kilograms of fresh forage; and burning, only 114.75 kilograms of fresh forage. Thus, in order of production of pasture grasses, grubbing was first, cutting was second and burning was third. This order of production was repeated in the second period, when the sub-lots under grubbing yielded the heaviest crop of fresh forage, 200.24 kilograms, and burning the lowest, only 137.01 kilograms, cutting with 181.59 kilograms, standing intermediate. In the third period, again grubbing with 226.62 kilograms was highest in fresh forage production, cutting with 186.96 kilograms was second, and burning with only 150.01 kilograms was lowest.

The data obtained during the three periods, consistently show that grubbing gave the best yield of fresh forage; cutting, second; and burning, the lowest. It may be seen in table 4 that during the first period, when grubbing was compared with cutting, grubbing was the better by 0.37 ± 0.55 kilogram. When grubbing was compared with burning, grubbing was the better by 0.19 ± 0.63 kilogram. When cutting was compared with burning, cutting was the better by 0.42 ± 0.60 kilogram. It is apparent from these results that during the first period of the experiment, the apparent advantages of one treatment over another in yield were not statistically significant.

In the second period, when grubbing was compared with cutting, grubbing was the better by 2.07 ± 1.07 kilograms, showing again that the superiority of grubbing over cutting was not significant. However, when grubbing was compared with burning, grubbing was the better by the highly significant difference of 7.03 ± 1.12 kilograms, showing that grubbing decidedly stimulated high production. And when cutting was compared with burning, cutting was the better by the significant difference of 4.95 ± 1.04 kilograms.

In the third period, the comparisons show even more marked differences between the treatments. When grubbing was compared with cutting, grubbing was the better by the significant difference of 4.41 ± 0.48 kilograms. When grubbing was compared with burning, grubbing was the better by the very significant difference of 8.51 ± 0.71 kilograms. When cutting was compared with burning, cutting was the better by the significant difference of 4.11 ± 0.54 kilograms. A rather important feature of the data in table 4 is the disclosure of the fact that there was a disproportionate decrease in production of the sub-lots under burning when compared with grubbing and cutting. Grubbing, compared with burning, was the better by the difference of 0.19 ± 0.63 kilogram during the first period, 7.03 ± 1.12 kilograms in the second period, and 8.51 ± 0.70 kilograms in the third. Cutting, compared with burning, was the better by the difference of 0.42 ± 0.60 kilogram in the first period, 4.95 ± 1.04 kilograms in the second, and 4.11 ± 0.54 kilograms in the third. These figures may be interpreted to mean that the practice of continually burning off of pasture grass lands year after year is detrimental to the production of grasses.

The heavy increase in production in sub-lots under grubbing may have been due to the light cultivation of the area. This was observed by Griffiths (1907) in his experiments in reseeding pastures. On the other hand, the disproportionate decrease of forage production in the sub-lots under burning could be attributed only to the detrimental effects on cogon grass of this particular treatment. Inasmuch as cogon is the most common pasture grass in the Philippines, it does not seem, from these results, that permanent improvement can be secured solely by setting fire to large areas of cogon lands.

The chemical composition of the cogon grass

To find out to what extent the treatment affected the chemical composition of the grass, samples were sent for analysis to the Department of Agricultural Chemistry. But owing to the fact that only one sample from each treatment could be analyzed in each of the tree periods covered, the results are of value only as indicating general trends. It may be seen in table 5 that there is no appreciable difference among the constituents as influenced by the different methods of improvement, except in moisture, protein, and dry matter contents of the grass. Analyses of the samples from sub-lots under burning gave an average of 59.73 per cent of moisture during the three periods; grubbing, 59.37 per cent; and cutting, 57.52 per cent. If the high moisture content of the grass is an indication of succulence, these data would show that the grasses from sub-lots under burning and grubbing were more succulent than those under cutting. Although the differences in moisture content in all the three periods were small; nevertheless, they were consistent in showing that cutting always stood the lowest in moisture content to burning and grubbing.

The analysis shows that the sub-lots under cutting consistently gave the highest percentage of dry matter throughout the three periods covered by the experiment. As between grubbing and burning, it was found that in the first two periods of the experiment burning had a higher percentage of dry matter than grubbing, but in the third period the reverse was true. The averages of the three periods for dry matter were as follows: cutting, 42.48 per cent; grubbing, 40.63 per cent; and burning, 40.27 per cent.

In so far as protein content is concerned, it was found that during the first period the sub-lots under grubbing gave 3.56 per cent protein; burning, 1.79 per cent; and cutting, 1.41 per cent. In the second period, cutting gave 3.13 per cent; grubbing, 2.31 per cent; and burning, 2.10 per cent. In the third period, cutting gave 3.66 per cent; grubbing, 1.53 per cent; and burning, 1.32 per cent. The average for the three periods placed cutting first with 2.73 per cent; grubbing, second, with 2.47 per cent; and burning, third, with 1.74 per cent. The explanation for this result is that in sub-lots that were burned, the cogon grass grew rather quickly, whereas in the sub-lots that were cut, growth took place rather slowly, with grubbing standing intermediate. So when samples of grass for analysis were taken, the grass under burning was relatively older and that under cutting, relatively younger. This fact accounts for the high protein content of samples under cutting, it being known that younger plants are richer in protein than the older ones (Henry and Morrison, 1929).

Ratio of pasture grasses to weeds

The numerical ratio of pasture grasses to weeds has been used as an indication of the efficiency of methods of improving pastures. It is a common knowledge that any weed may be a potential menace to grasses in a pasture. Thus, in the years 1936 and 1937, the pastures of the Department of Animal Husbandry were threatened with destruction by the prevalence of lantana (*Lantana camara* Linn.), and only after a very systematic weeding out of these plants did we succeed in getting rid of them.

The total number of pasture grasses and weeds and their ratios expressed in percentage, as obtained from the quadrats located in the middle of each of the sub-lots, may be seen in table 6. During the first period, grubbing, with 13,090 grasses and 147 weeds, or a ratio of 89 grasses to 1 weed, was the best; cutting, with a total of 14,424 grasses and 406 weeds, or a ratio of 35 grasses to 1 weed, second; and burning, with a total of 9,897 grasses and 303 weeds, or a ratio of 33 grasses to 1 weed, last. In the second period, grubbing, with 10,452 grasses and 66 weeds, or a ratio of 158 grasses to 1 weed, was again the best; cutting, with a total of 10,443 grasses and 114 weeds, or a ratio of 92 grasses to 1 weed, second; and burning, with a total of 9,923 grasses and 192 weeds, or a ratio of 52 grasses to 1 weed, last. During the third period, grubbing, with 11,197 grasses and 57 weeds, or a ratio of 196 grasses to 1 weed, was again first; cutting, with 9,086 grasses and 89 weeds, or a ratio of 102 grasses to 1 weed, second; and burning, with 8,769 grasses and 97 weeds, or a ratio of 90 grasses to 1 weed, last. These data show conclusively that grubbing was the most efficient treatment in eliminating the weeds; cutting, second; and burning, the least efficient. As to the effect of burning on the number of weeds, the data found in the present studies are in agreement with those of Hensel (1923), since it is clear that the number of weeds decreased progressively in each succeeding treatment. Enumeration of the plants in the quadrats in each of the 27 sub-lots under the three different treatments were made, and the figures obtained were treated statistically for purposes of comparison. When grubbing was compared with cutting, cutting was the better by the difference of 148.22 ± 76.07, which was not significant. In the second and third periods, grubbing was better in so far as grass production is concerned, but the differences were not significant in the second period, but were in the third period. This inconsistency is further verified when grubbing was compared with burning. In the first period, grubbing was the better by the significant difference of 354.79 ± 104.21, but insignificant in the second period (58.78 ± 51.26) and significant in the third period (269.78 ± 75.83). When cutting was compared with burning, in the first period, cutting was significantly the better by the difference of 503.00 ± 113.02, but insignificant in the second period (57.78 ± 58.32) and also insignificant in the third period (35.22 ± 60.27). If the general trend as shown in the experiment would be followed, it seems that grubbing will be decidedly better than either cutting or burning and that cutting will be decidedly better than burning if the operation will be continued for a longer time.

The experimental plots at the beginning and at the completion of these studies are shown in figures 2 and 3. It may be seen in figure 2 that the vegetation of the experimental lots at the beginning of the experiment was full of weeds and did not show much difference from the pasture outside the fence surrounding it. At the termination of the experiment, however, the weeds as shown in figure 3 had practically disappeared, thereby causing a marked difference in vegetation between the experimental lots and the pasture area surrounding it.

Combination treatments

The practice in vogue in the Philippines is to set fire to pasture areas in dry seasons, thus incurring practically no cost of operation, for the grasses burn quickly. But we have just seen that continual burning off of cogon grass exerted an adverse influence on their stand. Also, the treatment of burning period after period has resulted in the preponderance of weeds. On the other hand, cutting and grubbing did not have these objections. But, as may be expected the expenses incurred in cleaning pastures by up-rooting non-pasture plants or of cutting the weeds were considerable. Our data place the cost of cleaning pastures by grubbing at ₱9.57 per hectare, with the rate of labor at ten centavos per man hour. The cost would, of course, vary, depending upon the stand of weeds in a given area and other factors. From the point of view of economy, therefore, all the possible combinations of the three methods were tried out.

In one series of experiments the following combinations were made: (*a*) cutting, followed by grubbing and finally burning; (*b*) grubbing, followed by burning and finally cutting; (*c*) burning, followed by cutting, and finally grubbing. The intervals between treatments were about three months. In another series of experiments the combination of treatments tried were: (*d*) cutting, burning, and grubbing; (*e*) grubbing, cutting, and burning; and (*f*) burning, grubbing, and cutting. The data obtained showed combination treatment *d* (cutting, burning, and grubbing) to be the best, having yielded the heaviest crop of pasture grasses. Combination treatment *f* (burning, grubbing, and cutting), second. The poorest combination was *e* (grubbing, cutting, and burning). The intervals between treatments being about three months had afforded sufficient time for some weeds to grow large enough to be cut in the succeeding treatment.

These results are important from a practical standpoint, inasmuch as in combination treatment *d* (cutting, burning, and grubbing) the previous treatment makes the succeeding ones easier to perform thereby reducing the cost of pasture improvement. The combination treatment *e* is, not only impracticable under range conditions, but also most expensive. In the matter of reducing the stand of non-pasture plants or weeds, combination treatment *f* was as effective as combination treatment *d*. Hence, one may substitute the other whenever climatic conditions demand a change.

Minor observations

It was consistently observed that the young grasses in the sub-lots under burning appeared earlier than those in the sub-lots under other treatments. The grasses in the sub-lots under burning were darker green in color than those in the other sub-lots. Hensel (1923) reports similar observations in the United States and explains that the early growth of grasses in burned areas was stimulated by the higher temperature, as a result of the direct exposure of the bare ground to the sun.

In October, 1932, when the cattle in the breeding herd of the Department of Animal Husbandry broke into the experimental lots, they preferred the grasses in the treatment burning and did not graze on the sub-lots under the other treatments. This accidental intrusion of the animals into the experimental lots was repeated in October, 1933 by carabaos and the same observation as to preference of animals for grass in the burned lots was noted.

This selective grazing may be explained by the more succulent appearance of the grasses in the sub-lots under burning. The odor of the decomposing grasses in the sub-lots under grubbing and cutting, where the cut grasses were left in the field to decompose, may have exerted some repulsive influence.

In summer of 1933, the grasses which had grown for about two months in the sub-lots under burning wilted in the daytime, a feature not markedly visible in those of the sub-lots under grubbing and cutting. This difference in wilting may be explained by the mulching effect of the dried grasses which had been left in the sub-lots that were under grubbing and cutting.

The grasses in the sub-lots under burning flowered much earlier than those in the sub-lots under the other treatments, grubbing and cutting.

SUMMARY AND CONCLUSIONS

1. The effects on the production of grasses of three different methods of pasture management are reported in this paper.

2. The pasture grasses occurring in the experimental lots were: culape, laau-laau, *Paspalum conjugatum* Berg., sabung-sabuñgan, *Panicum flavidum* Retz.; cogon, *Imperata cylindrica* (Linn.) Beauv. var. *koenigii* (Retz.) Benth.; bakis-bakisan, *Eleusine indica* (Linn.) Gaertn.; mutha, *Cyperus rotundus* Linn.; talahib, *Saccharum spontaneum* Linn. subsp. *indicum* Hack.; alikbañgon, *Cyanotis* sp.; banig-usa, kaliraurau *Eragrostis viscosa* (Retz.) Trin.; agiñgai lalake, *Rottboellia exaltata* Linn., and *Cynodon arcuatus* Presl.

3. The weeds found were: dilang-aso, *Elephantopus spicatus* Aubl.; puñgapung, *Amorphophallus campanulatus* (Roxb.) Blm.; silisilihan, *Synedrella nodiflora* (Linn.) Gaertn.; isis, *Ficus ulmifolia* Lam.; sambong, *Blumea balsamifera* (Linn.) DC.; guava, *Psidium guajava* Linn.; kampupot, pandakaki, *Tabernaemontana pandacaqui* Poir.; takip kohol, *Centella asiatica* (Linn.) Urban.; eskoba, *Sida retusa* Linn.; palis, *Callicarpa cana* Linn.; dayang, *Cyathula prostrata* (Linn.) Blm.; balatong-aso, *Cassia tora* Linn.; hauili, *Ficus hauili* Blanco; tugli, *Derris elliptica* (Roxb.) Benth.; Bulak-manok, *Vernonia patula* (Dry.) Merr.; kanlong, *Blumea laciniata* (Roxb.) DC.; balagun, mani-manian, *Teramnus labialis* (Linn. f.) Spreng.; magilik, *Premna cumingiana* Schauer; banato, *Mallotus philippensis* (Lam.) Muell.-Arg.; sampasampalukan, *Phyllanthus niruri* Linn.; sili, *Capsicum frutescens* Linn.; kabilan, *Columella trifolia* (Linn.) Merr.; mangkit, *Desmodium gangeticum* (Linn.) DC.; payang-payang, *Flemingia strobilifera* (Linn.) R. Br.; makahia, *Mimosa pudica* Linn.; saluyot, *Corchorus acutangulus* Lam.; *kulutkulutan, Triumfetta* sp.; aroma, *Acacia farnesiana* (Linn.) Willd.; and anonang, *Cordia dichotoma* Forst. f.

4. The beneficial effect of grubbing on the yield of pasture grasses was conclusively shown by the experiments. This effect was not so noticeable in the early stages of the work but progressed very markedly in the later stages. Cutting was found to be better than burning.

5. In moisture content, the grasses under burning and grubbing were first, with 59.73 and 59.37 per cent, respectively, and cutting, second, with an average moisture content of 57.52 per cent.

6. In protein content there was an average of 2.73 per cent for cutting, 2.47 per cent for grubbing, and 1.74 per cent for burning.

7. With the field under single treatment, the sub-lots under grubbing gave the smallest amount of weeds, those under cutting, second, and those under burning, the densest stand of weeds. This result has been verified in repeated series of experiments.

8. The combination treatment cutting, followed by burning, and finally grubbing gave the heaviest yield of pasture crop. This combination treatment was as effective in eradicating weeds as the combination burning, grubbing, and finally cutting; hence, one may be substituted for the other.

9. The combination treatment grubbing, cutting, and burning yielded the least amount of pasture grass.

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TABLE 1

Differences in weights of fresh pasture grasses by single treatments during three successive harvests

TREATMENTS COMPARED	FIRST HARVEST		SECOND HARVEST		THIRD HARVEST	
	Average yield	Difference	Average yield	Difference	Average yield	Difference
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Cutting and burning .	62.53 ± 1.41	11.73 ± 8.88	29.94 ± 2.76	3.00 ± 3.30	23.41 ± 3.09	2.24 ± 3.75
	50.80 ± 8.77		26.95 ± 1.81		21.17 ± 2.12	
Grubbing and burning	69.52 ± 9.32	18.72 ± 12.80	32.54 ± 3.47	5.60 ± 3.91	29.81 ± 4.10	8.64 ± 4.61
	50.80 ± 8.77		26.95 ± 1.81		21.17 ± 2.12	
Grubbing and cutting .	69.52 ± 9.32	6.99 ± 9.43	32.54 ± 3.47	2.60 ± 4.43	29.81 ± 4.10	6.40 ± 5.13
	62.53 ± 1.41		29.94 ± 2.76		23.41 ± 3.09	

TABLE 2

Average yields of pasture grasses by single treatments during the three successive harvests computed on the basis of one hectare

TREATMENTS COMPARED	FIRST HARVEST		SECOND HARVEST		THIRD HARVEST		AVERAGE	
	Average yield	Difference	Average yield	Difference	Average yield	Difference	Average yield	Difference
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Cutting and burning .	25012	4692	11976	1200	9364	896	15450.67	2262.67
	20320		10776		8468		13188.00	
Grubbing and burning	27808	7488	13016	2240	11924	3456	17582.67	4394.67
	20320		10776		8468		13188.00	
Grubbing and cutting .	27808	2796	13016	1040	11924	2560	17582.67	2132.00
	25012		11976		9364		15450.67	

TABLE 3

Fresh weights of the yields of the different sub-lots of pasture grasses and weeds under grubbing, cutting, and burning during the three periods

	GRUBBING		CUTTING.		BURNING	
	Grasses	Weeds	Grasses	Weeds	Grasses	Weeds
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
First period	38.65	18.82	33.23	13.19	29.67	— [a]
	41.73	17.18	42.77	7.35	43.95	—
	41.49	16.28	42.50	14.02	41.13	—
Total	121.87	52.28	118.50	34.56	114.75	—
Second period ..	58.41	3.89	68.21	5.75	42.07	—
	76.21	4.98	65.40	5.85	53.12	—
	65.54	3.13	37.98	5.71	41.82	—
Total	200.24	12.00	181.59	17.31	137.01	—
Third period ...	76.90	5.67	64.99	3.63	64.18	—
	75.61	10.75	61.83	3.35	59.24	—
	74.11	3.04	60.14	3.86	44.59	—
Total	226.62	19.46	186.96	10.84	150.01	—

[a] On these sub-lots the weeds were left unmolested to be burned later, thus simulating the actual range practice.

TABLE 4

Differences in weights of fresh pasture grasses of lots I, II, and III during the first, second, and third periods

	FIRST PERIOD		SECOND PERIOD		THIRD PERIOD	
	Yield	Difference	Yield	Difference	Yield	Difference
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Grubbing and cutting .	13.54 ± 0.61		22.25 ± 1.17		25.18 ± 0.71	
	13.17 ± 0.53		20.18 ± 0.97		20.77 ± 0.23	
		0.37 ± 0.55		2.07 ± 1.07		4.41 ± 0.48
Grubbing and burning	13.54 ± 0.61		22.25 ± 1.17		25.18 ± 0.71	
	12.75 ± 0.73		15.22 ± 1.20		16.67 ± 0.77	
		0.19 ± 0.63		7.03 ± 1.12		8.51 ± 0.70
Cutting and burning .	13.17 ± 0.53		20.18 ± 0.97		20.77 ± 0.23	
	12.75 ± 0.73		15.22 ± 1.20		16.67 ± 0.77	
		0.42 ± 0.60		4.95 ± 1.04		4.11 ± 0.54

TABLE 5

Analysis of the cogon grass, expressed in percentage of samples taken from the different sub-lots under grubbing, burning, and cutting during the first, second and third period

	GRUBBING				CUTTING				BURNING			
	First period	Second period	Third period	Average	First period	Second period	Third period	Average	First period	Second period	Third period	Average
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Moisture	50.77	58.55	68.78	59.37	49.59	56.00	66.97	57.52	50.05	58.34	70.80	59.73
Fats (ether extract) .	1.75	1.66	0.85	1.42	2.52	1.79	0.76	1.69	2.81	1.57	0.69	1.69
Ash	3.26	3.11	2.77	3.05	3.58	3.57	2.49	3.21	3.10	3.20	2.66	2.99
Protein (N × 6.25) ..	3.56	2.31	1.53	2.47	1.41	3.13	3.66	2.73	1.79	2.10	1.32	1.74
Crude fiber	16.35	14.87	11.42	14.21	16.72	15.11	11.07	14.30	16.55	14.85	9.49	13.46
Carbohydrates (N.F.E.)	24.31	19.50	14.65	19.47	26.18	20.40	15.05	20.54	25.70	19.94	15.04	20.23
Calories per 100 grams	131.00	105.00	74.00	103.00	137.00	113.00	84.00	111.33	139.00	105.00	74.00	106.00
Dry matter	49.23	41.45	31.22	40.63	50.41	44.00	33.03	42.48	49.95	41.66	29.20	40.27

TABLE 6

Total number of pasture grasses and weeds and the ratio of weeds to pasture grasses obtained in the quadrat located at the middle of each sub-lot during the three different periods under grubbing, cutting, and burning

	GRUBBING		CUTTING		BURNING	
	Grasses	Weeds	Grasses	Weeds	Grasses	Weeds
	number	*number*	*number*	*number*	*number*	*number*
First period	4,016	74	4,180	118	2,338	132
	4,295	49	5,746	108	4,236	90
	4,779	24	4,498	180	3,323	81
Total	13,090	147	14,424	406	9,897	303
Ratio of grasses to weeds	89:1		35:1		33:1	
Second period ..	3,311	20	3,426	32	3,935	95
	3,567	30	3,527	45	3,783	54
	3,574	16	3,490	37	3,205	43
Total	10,452	66	10,443	114	9,923	192
Ratio of grasses to weeds	158:1		92:1		52:1	
Third period ...	4,558	34	3,049	41	3,091	74
	3,354	17	3,551	32	3,061	9
	3,287	6	2,486	26	2,617	14
Total	11,197	57	9,086	89	8,769	97
Ratio of grasses to weeds	196:1		102:1		90:1	

COMPARATIVE NUTRITIVE VALUES OF AMMONIUM SULFATE AND DIAMMONIUM PHOSPHATE FOR UPLAND RICE[1]

MAGNO M. MAMAÑGON

WITH TWO TEXT FIGURES

Results of fertilizer culture studies conducted in the Department of Agricultural Botany at Los Baños have shown, among other things, that ammonium sulfate fertilizer added in proper amounts to Lipa clay loam in pots was conducive to good growth and a high yield of upland rice. The yields of tops were always favorably influenced by the amount of the fertilizer used. The addition of an excess amount of this fertilizer, however, was found to affect adversely the yield of grains—causing delayed fruiting, lack of uniformity in the ripening of the grains, and a material decrease in yield.

It might be possible that the adverse effects of the excess of ammonium sulfate fertilizer were due to the improper ratio of N to P in the soil. To determine if such was the cause, Talamisan (1938) employed in pot cultures ammonium sulfate and superphosphate in different combinations for upland rice. Instead of the two fertilizers being used in a mixture, it was thought interesting to try diammonium phosphate, a fertilizer which is not a physical mixture, that would add to the medium both N and P.

Review of literature

In clay loam in pots, upland rice plants were grown supplied with varying amounts of ammonium sulfate fertilizer. Almeda (1937) found marked increases in ash contents of tops as the plants grew older and as the amount of ammonium sulfate fertilizer was increased. The degree of tillering was also influenced, not only by the age of the plant, but also by the amount of ammonium sulfate fertilizer used as well. He found that the best N-P_2O_5-K_2O ratio was approximately 10-30-40 for clay loam and 9.37-24.5-38.5 for tuff soil. In terms of dry weight and number of panicles, however, the best N-P_2O_5-K_2O ratio in clay loam was approximately 11-15-42, while, in tuff soil, the ratio was 10-25-39. He also found that ammonium sulfate tended to delay fruiting and to produce lack of uniformity in the ripened grains.

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[1] Experiment Station contribution No. 1249. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

The chlorophyll contents of the leaves of upland rice plants were also affected by the amount of ammonium sulfate fertilizer applied. Soriano (1934) found that as the amount of ammonium sulfate used was increased, the chlorophyll content of the leaves was likewise increased. On the other hand, Libatique (1931) found that upland rice plants that had been fertilized with varying amounts of ammonium sulfate produced more numerous but shorter roots than those from the control cultures. These adverse results on the length of the roots were obtained especially from the cultures that were rather liberally supplied with the fertilizer.

Literature on the effects upon rice plants of diammonium phosphate appears to be wanting; the only avaialble report on this fertilizer, but with another plant, is one from Australia. In that country, Richardson and Gurney (1933) obtained an increase of 3.2 bushels from the cultures that had been supplied with superphosphate and an increase of 3.9 bushels from those that received diammonium phosphate per acre over the unfertilized cultures.

Objects of this study

The objects of this study were (*a*) to determine the comparative nutritive effects on upland rice of ammonium sulfate and diammonium phosphate fertilizers when added to Lipa clay loam, (*b*) to determine the optimum amount and the right time to apply the fertilizers, and (*c*) to determine the N-P_2O_5-K_2O contents of culture media apparently best for upland rice in the lot.

Time and place of this study

The experimental part of this study was conducted in the experimental yard of the Department of Agricultural Botany from June 30, 1937, to February 12, 1938.

MATERIALS AND METHODS

The plant

The upland rice plants, variety Carreon, were started from seeds obtained from the Department of Agronomy. The seeds were soaked in water for 24 hours and afterwards sown four to a pot. When the young plants were one week old, some of them were pulled up, and only two young plants of about the same degree of development were left in each pot.

The soil

Lipa clay loam was gathered from a lot behind the Administration Building of the College. It was pulverized, sieved, and thoroughly mixed. Exactly 18.7 kgm. of air-dry soil were placed in each pot. This soil was found to contain 0.13 per cent N, 0.20 per cent P_2O_5, and 0.37 per cent K_2O (Enrile, 1938).

The cultures and fertilizers used

For determination of best cultures. Two kinds of fertilizers were used, namely, diammonium phosphate and ammonium sulfate. According to the dealers where these were purchased, diammonium phosphate contained 21 per cent N and 53.4 per cent P_2O_5, while the ammonium sulfate contained 20.6 per cent N. The fertilizers were applied to the soil in pots at the time of planting, each at the rate of ¼. ½, ¾, 1, 1¼, 1½ 1¾, and 2 tons per hectare. The actual amounts that were added to the cultures were 1.45, 2.9, 4.35, 5.8, 7.45, 8.7, 10.15, and 11.6 grams per pot. There were two sets of cultures one for the diammonium phosphate and the other for the ammonium sulfate. The set that received the diammonium phosphate consisted of eight cultures, each of which was run in triplicate, and the set that received the ammonium sulfate fertilizer had the same number of cultures and the same number of replications. The culture numbers and actual amounts of fertilizers used are recorded in table 1.

For determination of best time to apply. The application of 11.6 grams was found to be the best for diammonium phosphate, and that of 8.7, the best for ammonium sulfate. Each of these two applications was made 5 days before planting, at planting, and 5, 10, 20, 30, 40, and 50 days after planting. The number of cultures and replications that were run with diammonium phosphate was the same as those with ammonium sulfate.

Care of cultures

The cultures were run in the experimental yard of the Department of Agricultural Botany, where they were exposed to the same conditions of environment. They were cultivated and watered as occasion demanded, and insect pests and weeds were destroyed as soon as discovered.

EXPERIMENTS AND RESULTS

Pot cultures tried and results obtained

Two series of pot cultures were tried. The first was started on June 30, 1937, and harvested on October 20, of the same year. It consisted of two sets of cultures, eight with varying amounts of diammonium phosphate, and the same number with varying amounts of ammonium sulfate. Each culture was run in triplicate and a triplicate control or unfertilized culture was included. Three days before being harvested, the cultures were photographed (fig. 1).

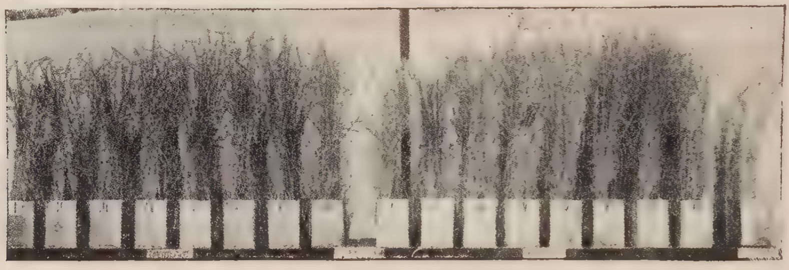

Fig. 1.—Rice plants 110 days old grown in Lipa clay loam to which (cultures at left) varying amounts of diammonium phosphate and (cultures at right) varying amounts of ammonium sulfate were added. (Amounts of fertilizers used and data obtained in table 1).

The experimental data [2] that were obtained are recorded as averages in table 1.

The second series of pot cultures was started on October 24, 1937, and the plants were harvested on February 12, 1938. In this series, the only cultures that had produced the best results in the first were included. This series consisted of two sets of cultures, eight with 11.6 grams of diammonium phosphate supplied to plants at different times, and another eight with 8.7 grams of ammonium sulfate. Each of these cultures was run in triplicate in which three unfertilized cultures, which served as control, were included. Three days before harvest was made, the cultures were photographed

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[2] The mass of original data is on file in the Department of Agricultural Botany.

(fig. 2). The experimental data[3] obtained are recorded as averages in table 2.

Criteria of results

The criteria of results used were (*a*) height of plants, (*b*) number of culms, (*c*) number of panicles, (*d*) dry weight of grains, (*e*) dry weight of tops, (*f*) dry weight of roots, and (*g*) dry weight of tops and roots.

Height of plants. The data on height of plants were obtained at the time of harvest. Measurements were made from the base of the culms in each culture to the tip of the tallest leaf. The data obtained from the three similar cultures were averaged.

Number of culms. The culms of the two plants in each pot were counted and recorded at the time of harvest. The average data in the tables were obtained by adding together the number of culms present in the three similar cultures and the sum was divided by 3.

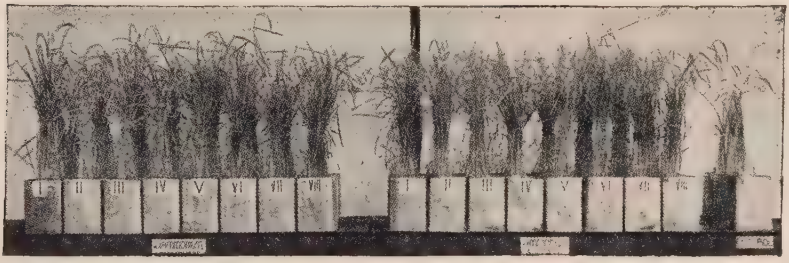

Fig. 2.—Rice plants 106 days old grown in Lipa clay loam. Cultures at left each received 11.6 grams of diammonium phosphate supplied at different times. Cultures at right each received 8.7 grams of ammonium sulfate applied at different times. (Time of application of fertilizer and data obtained in table 2)

Number of panicles. The number of panicles of the two plants in each pot were counted and recorded at the time of harvest. The average data in tables 1 and 2 were obtained by adding together the number of panicles present in the three similar cultures and dividing the sum by 3.

Dry weight of grains. After being harvested, the panicles from each culture were placed in paper bags and labelled. Then they were dried in the sun and further dried in an electric oven at 110°C, for over a night. When fully dried, those from the different cultures were separately weighed on an analytical balance, and the average weight from the three similar cultures was computed.

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[3] See foot-note 2.

Dry weight of tops. The tops from each culture were first dried in the sun and then wrapped in paper, labelled, and placed in an electric oven for further drying to constant weight. When fully dried, those from the three similar cultures were separately weighed, and the data obtained were averaged.

Dry weight of roots. The roots were taken out of the soil, carefully washed with water, and dried in the sun. Then the harvest from each culture was placed in a paper bag, labelled, and further dried in an electric oven to constant weight. The data obtained from the three similar cultures were averaged.

Dry weight of tops and roots. The dry weights of tops and roots obtained from each culture were added together.

DISCUSSION OF RESULTS

Comparative nutritive values of ammonium sulfate and diammonium phosphate

As may be seen in fig. 1, cultures I to VIII, which were supplied with either ammonium sulfate or diammonium phosphate, had much more well-developed upland rice plants than IX, the unfertilized culture. Fig. 1 also shows that varying the rates of application of either fertilizer from 1.45 grams per pot of two plants or at the rate of ¼ ton per hectare to 11.6 grams per pot or 2 tons per hectare resulted in different stands of the plants. More detailed comparisons of the different cultures tried, however, may be had by comparing the data in table 1.

Owing to the presence of rather divergent or irregular data under each criterion of results in table 1, the selection of the best culture in each set was not an easy matter. For this reason, the three highest values under each criterion in the diammonium phosphate set were arbitrarily selected and indicated by H's in table 1. Similarly, the three highest values in the ammonium sulfate set were also arbitrarily selected and indicated by H's in the same table. The results showed that most of the H's fall in VI to XIII, inclusive, in the cultures that were supplied with varying amounts of diammonium phosphate. In those that received ammonium sulfate, the good results, under the different criteria employed, appeared to be from cultures V to VIII, inclusive. The cultures which received from 8.7 to 11.6 grams of diammonium phosphate, and those that received from 7.45 to 11.6 grams of ammonium sulfate may, therefore, be considered as fairly good for the upland rice plant. Further study of the data in each of these selected cultures revealed the fact that, in terms of the yields of grains and of tops and roots, culture VIII, which received 11.6 grams of diammonium phosphate, or at the rate of 2 tons per hectare, and culture VI, which received 8.7 grams of ammonium sulfate, or at the rate of 1½ tons per hectare, may be considered the best in both sets.

The best culture in the diammonium phosphate set is compared in terms of the data on dry weight with the best in the ammonium sulfate set, and these two are compared with the control. The results expressed in relative values are given in the table that follows.

TABLE A

CULTURE NO.[a]	FERTILIZER AND AMOUNT APPLIED	DRY WEIGHT OF			
		Grains	Tops	Roots	Tops and roots
VIII	11.6 gm. diammonium phosphate	177	256	159	229
VI	8.7 gm. ammonium sulfate	196	336	174	292
IX	(Control)	100 (29.1 gm.)	100 (46.9 gm.)	100 (16.9 gm.)	100 (63.8 gm.)

[a] The culture numbers refer to those found in table 1.

The data in the above table again conclusively show that the fertilized cultures were far superior to the unfertilized; the superiority ranged from 159 per cent to as much as 336 per cent. In term of averages of the data under the different criteria, culture VIII, which received 11.6 grams of diammonium phosphate, was 205 per cent better than the control, while VI, which received 8.7 grams of ammonium sulfate, was 249 per cent better than the control. The best ammonium sulfate culture was 44 per cent better than the best diammonium phosphate treatment. To this culture, 8.7 grams of ammonium sulfate were added to the Lipa clay loam, or at the rate of 1½ tons per hectare.

It should be said that the effects on color of the leaves of the two ammonium fertilizers studied were quite similar. As the amount of either fertilizer was increased, rice leaves of a more intense green were produced. Both fertilizers also appeared to have similar effects on the development or maturity of grains. The characteristic lack of uniformity in the ripening of the rice grains on the same panicle was also observed in this study, not only in cultures supplied with relatively large amounts of ammonium sulfate, but also in those fertilized with the diammonium phosphate.

Optimum time to apply diammonium phosphate and ammonium sulfate

As shown by the relative stand of the plants in fig. 2 and by the data in table 2, the fertilized cultures were more or less equally well-developed, in spite of the differences of the time of application of the fertilizer. It was, therefore, somewhat difficult to select the best culture in the lot. When the three highest values under each criterion in the diammonium phosphate group and in the ammonium sulfate were arbitrarily selected and indicated by H's in table 2, it was revealed that some of the cultures received all or most of the H's, while others received none or only a few H's. Thus, in the diammonium phosphate group, culture V received 7 H's, or the maximum number of H's; VI, 4 H's; and VII, 3 H's. These may probably be considered as good cultures, with V, which received 11.6 grams of diammonium phosphate 20 days after planting, as slightly the best. On the other hand, in the ammonium sulfate group, culture V received 7 H's, or the maximum number possible; VI, 3 H's; and VII, 5 H's. These three may, therefore, be considered as good cultures, with V, which received 8.7 grams of ammonium sulfate 20 days after planting, as again slightly the best. In other words, the cultures that received 11.6 grams of diammonium phosphate or 8.7 grams of ammonium sulfate within 20 to 40 days after planting may be considered as good, with the one that received the fertilizer 20 days after planting as slightly the best in each set.

A comparison of the best culture in the diammonium phosphate group with the best in the ammonium sulfate lot, and these with the control, is given in table B. In this text table, the actual values from table 2 were converted into relative values, with the data from the control arbitrarily taken as 100.

TABLE B

CULTURE NO.[b]	FERTILIZER AND AMOUNT APPLIED	DRY WEIGHT OF			
		Grains	Tops	Roots	Tops and roots
I	11.6 gm. diammonium phosphate applied 20 days after planting	367	311	138	257
II	8.7 gm. ammonium sulfate applied 20 days after planting	386	302	139	253
III	(control)	100 (7.7 gm.)	100 (15.5 gm.)	100 (6.9 gm.)	100 (22.4 gm.)

[b] Culture I in here corresponds to culture V in upper portion of table 2; culture II, to culture V in the lower portion of the same table; and culture III, the control or culture IX in table 2.

It will be seen in the preceding table that, under the different criteria employed, cultures I and II may be considered about equally good for upland rice. For in term of average of the relative values under the different criteria, culture I was 268 per cent and culture II, 270 per cent better than the control. Between cultures I and II, there was a difference of only 2 per cent in favor of the latter. In other words, the culture that received 8.7 grams of ammonium sulfate 20 days after planting was only a little better than that which received 11.6 grams of diammonium phosphate also 20 days after planting.

The N-P_2O_5-K_2O contents of the best culture media

From the comparative study of the data in tables 1 and 2, it was revealed that of the two best cultures, one came from the diammonium phosphate set, and the other, from the ammonium sulfate set. To the first culture, 11.6 grams of diammonium phosphate were added to Lipa clay loam, to the other, which contained the same kind and amount of soil, 8.7 grams of ammonium sulfate were added.

Since the diammonium phosphate contained 21 per cent N and 53.4 per cent P_2O_5, the 11.6 grams of this fertilizer must have added to the soil 2.44 grams of N and 6.19 grams of P_2O_5. If these plant food constituents were to be added to those originally present in the 18.7 kgm. of Lipa clay loam in pots, the N-P_2O_5-K_2O contents of the culture would be 26.75 grams of N, 43.59 grams of P_2O_5, and 69.19 grams of K_2O.

The other good culture medium was fertilized with 8.7 grams of the sulfate of ammonia. Since this fertilizer contained 20.6 per cent of N, the amount of N that was added to the soil from the fertilizer was 1.79 grams. If this plant nutrient were to be added to those originally present in the 18.7 kgm. of soil, the $N-P_2O_5-K_2O$ contents of this culture would be 26.1 grams of N, 37.4 grams of P_2O_5, and 69.19 grams of K_2O.

SUMMARY AND CONCLUSIONS

1. The application to upland rice, at the time of planting, of 8.7 to 11.6 grams of diammonium phosphate or 7.45 to 11.6 grams of ammonium sulfate produced fairly good results.

2. In terms of the yields of grains and of tops and roots, culture VIII, which received at the time of planting 11.6 grams of diammonium phosphate, or at the rate of 2 tons per hectare, and culture VI, which received 8.7 grams of ammonium sulfate, or at the rate of 1½ tons per hectare, were the best in the two series of cultures.

3. In term of averages, culture VIII was 205 per cent better than the control, whereas culture VI was 249 per cent better than the control.

4. The best culture of the ammonium sulfate series was obtained when 8.7 grams of ammonium sulfate were added to Lipa clay loam, or at the rate of 1½ tons per hectare, at the time of planting. This culture was 44 per cent better than the best diammonium phosphate culture.

5. In spite of the differences of the time of application of the fertilizers the fertilized cultures became more or less equally well-developed.

6. The cultures that received 11.6 grams of diammonium phosphate or 8.7 grams of ammonium sulfate within 20 to 40 days after planting were good, but the plants that were fertilized 20 days after planting were the best.

7. The culture that was fertilized with 8.7 grams of ammonium sulfate 20 days after planting was a little better than that which received 11.6 grams of diammonium phosphate 20 days after planting.

8. The best diammonium phosphate culture contained 26.75 grams of N, 43.59 grams of P_2O_5, and 69.19 grams of K_2O; and the best ammonium sulfate culture had 26.1 grams of N, 37.4 grams of P_2O_5, and 69.19 grams of K_2O.

9. Both the diammonium phosphate and the ammonium sulfate fertilizers had the tendency to cause upland rice to produce dark green leaves. The rice also lacked uniformity in the ripened grains.

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TABLE 1

Average data obtained from rice grown in clay loam in pots supplied with varying amounts of diammonium phosphate and ammonium sulfate fertilizers at the time of planting

(Experiment from June 30, to October 20, 1937)

DIAMMONIUM PHOSPHATE

CULTURE NO.	AMOUNT OF FERTILIZER USED	HEIGHT OF PLANTS	CULMS	PANICLES	DRY WEIGHT			
					Grain	Top	Root	Top and root
	grams	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
I	1.45	122.0	17.3	15.3H	25.3	57.9	21.1	79.0
II	2.9	139.7	17.7	14.0	30.0	67.6	23.4	91.0
III	4.35	136.8	20.0H	14.3	35.1H	81.0	30.3H	111.3
IV	5.8	133.8	18.3	14.3	36.5H	89.6	27.4H	117.0H
V	7.45	138.6	17.0	11.3	31.3	85.3	25.3	110.6
VI	8.7	146.3H	23.0H	14.0	32.6	107.6H	26.3	133.9H
VII	10.15	142.8H	18.0	16.0H	30.9	92.8H	16.1	108.9
VIII	11.6	138.8H	23.0H	18.7H	51.5H	119.5H	26.9H	146.4H
AMMONIUM SULFATE								
I	1.45	127.1	16.3	13.0	28.6	56.3	18.1	74.4
II	2.9	139.6	17.7	13.0	31.8	68.8	21.1	89.9
III	4.35	144.9	21.3	18.7	42.5	107.7	24.4	132.1
IV	5.8	153.2H	19.0	15.3	39.3	106.8	26.9	133.7
V	7.45	160.3H	24.7	17.7	56.8H	143.1H	28.3H	171.4H
VI	8.7	159.9H	27.7H	20.7H	57.0H	157.0H	29.5H	186.5H
VII	10.15	146.9	25.0H	19.3H	53.0	142.3	28.2	170.5
VIII	11.6	145.0	29.0H	22.7H	53.9H	149.0H	30.8H	179.8H
IX	control	122.7	11.7	10.7	29.1	46.9	16.9	63.8

TABLE 2

Average data obtained from rice plants grown in clay loam in pots supplied with diammonium phosphate and ammonium sulfate at different times

(Experiment from October 26, 1937, to February 12, 1938)

DIAMMONIUM PHOSPHATE

CULTURE NO.	TIME OF APPLICATION	AMOUNT OF FERTILIZER USED	HEIGHT OF PLANTS	CULMS	PANICLES	DRY WEIGHT OF Grain	DRY WEIGHT OF Top	DRY WEIGHT OF Root	DRY WEIGHT OF Top and root
		grams	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
I	5 days before planting ...	11.6	120.8	19.0H	11.3	18.0	38.4	8.7H	47.1
II	at planting	11.6	114.5	11.3	9.7	20.4	37.4	7.9	45.3
III	5 days after planting	11.6	131.5H	15.0	13.0	27.2H	34.0	8.9H	42.9
IV	10 days after planting	11.6	125.0	15.0	11.7	23.8	39.6	6.2	45.8
V	20 days after planting	11.6	126.5H	18.7H	17.0H	29.7H	48.2H	9.5H	57.7H
VI	30 days after planting	11.6	129.5H	18.0	15.3H	26.3	47.7H	8.5	56.2H
VII	40 days after planting	11.6	124.8	18.7H	15.0	20.3	43.3H	6.4	49.7H
VIII	50 days after planting	11.6	115.8	17.0	15.3H	27.5H	32.4	6.2	38.6
	AMMONIUM SULFATE								
I	5 days before planting ...	8.7	111.3	19.7H	15.3H	24.7	36.7	7.6	44.3
II	at planting	8.7	120.0	15.0	13.0	25.7	36.3	9.2H	45.5
III	5 days after planting	8.7	123.3H	13.7	11.3	28.4	33.1	7.1	40.2
IV	10 days after planting	8.7	118.8	15.3	12.6	28.5H	35.3	7.9	43.2
V	20 days after planting	8.7	123.8H	20.3H	16.3H	29.6H	47.0H	9.6H	56.6H
VI	30 days after planting	8.7	123.0	20.3H	14.3	23.5	46.2H	8.1	54.3H
VII	40 days after planting	8.7	120.3	19.0	15.0H	29.2H	42.2H	8.2H	50.4H
VIII	50 days after planting	8.7	120.5H	14.7	13.0	26.6	34.9	6.2	41.1
IX	(control)	—	98.7	9.3	5.7	7.7	15.5	6.9	22.4

THE INFLUENCE OF THE APPLICATION OF CERTAIN FERTILIZERS AND SOIL AMENDMENTS ON THE NITRIFYING AND DENITRIFYING POWER OF NANHAYA CLAY, A LOCAL ALLUVIAL SOIL[1]

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WITH THREE TEXT FIGURES

Nitrification, denitrification, etc., are due to the activities of soil microorganisms. These processes are directly or indirectly influenced by the application of fertilizers and soil amendments, by temperature, oxygen, moisture, and reaction of the soil.

The disappearance of large amounts of nitrates from the soil may be due to their reduction by microorganisms.

Review of literature

Smith and Brown (1930) showed that proper composting of straw and cellulose residues may stimulate both nitrification and nitrate assimilation in the soil.

Itano and Arakawa (1931) found that the relation of the rice crop to ammonification, nitrification, and denitrification was marked where a good crop was produced.

Smith and Brown (1931) noted that straw and partially decomposed straw and farm manure, applied to the soil, brought about an assimilation of nitrates immediately. The straw induced a larger assimilation of nitrates than the straw manure or the farm manure. Manure, lime, and rock phosphate applied over a period of several years on Marshall silt loam and Grundy silt loam tended, in general, to lower the nitrate assimilating power of the soil.

Tucay (1932) showed that the application of ammonium phosphate and ammonium sulfate stimulated the nitrifying power of the soils of the Maquiling area.

Craig and Geraud (1926) concluded that the application of a large amount of molasses arrested nitrification and converted ammonium compounds into organic nitrogenous compounds. Furthermore, molasses and dried green manure do not increase the loss of nitrogen in the gaseous form, but farmyard manure increases the loss of free nitrogen.

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[1] Experiment Station contribution No. 1250.

Pendleton, Brown and Smith (1929) found that the amount of nitrates assimilated by certain groups of microorganisms may be increased, (*a*) by using a very soluble form of organic matter such as starch, (*b*) by increasing the amount of nitrate added, and (*c*) by extending the period of incubation of the cultures.

Aquino and Javier (1932), pointed out that the different degrees of nitrifying power of soils may be attributed to their variation in soil reaction, topography, soil type, vegetation, system of cropping and to the distribution of micro-biological flora in the soil.

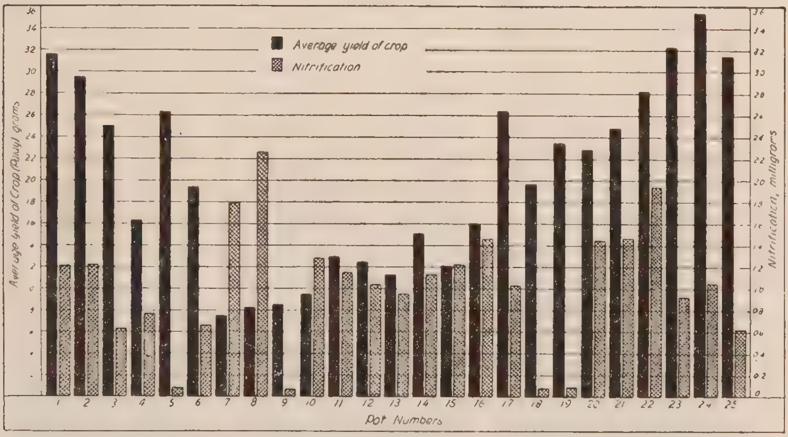

Fig. 1.—Average yield of crop and nitrifying power of the variously treated cultures

Espino and Pantaleon (1934), arrived at the conclusion that the presence of rice straw, rice straw ash, or both straw and ash in clay loam soil in pots was harmful to young rice and maize plants because these materials increase the hydrogen ion concentration of the soil.

Objects of the present study

The objects of this work were (*a*) to determine the influence of the application of certain fertilizers and soil amendments on the nitrifying and denitrifying power of Nanhaya clay, a local alluvial rice soil; and (*b*) to determine the growth and yield of rice, and their relation to the nitrifying and denitrifying capacity of the Nanhaya clay as affected by fertilizers and soil amendments.

MATERIALS AND METHODS

In this work Ramai variety of rice and Nanhaya clay, a local alluvial soil, were used. The soil was collected from the main rice field of the Experiment Station of the College of Agriculture at Los Baños.

Soil samples were taken from various places in the field. The soil was dug from zero to thirty centimeters deep and placed in boxes. The samples collected were mixed thoroughly and the large clods broken up. Crowns and roots of various kinds of weeds and other plants were removed.

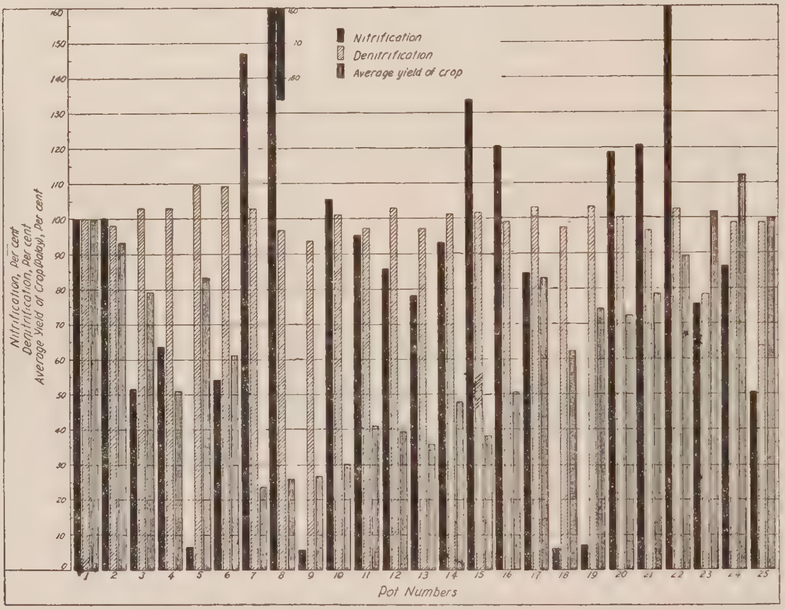

Fig. 2.—Nitrification, denitrification, and average yield of crop of the different treatments

One hundred water-tight petroleum cans were painted with coal tar. Each of the cans was filled with the Nanhaya clay soil to within 5 centimeters from the top. Four rice seedlings of Ramai variety were transplanted in each can. The cans were burried about twenty-five centimeters deep in the ground leaving exposed about ten centimeters, as shown in figure 3. The cans were arranged in twenty-five rows of four cans in a row, spaced about ten centimeters apart in both directions. The four cans in each row were designated as pot A, pot B, pot C, and pot D. The application of various fertilizers and soil amendments was made according to the following tabulation:

Quantity of fertilizers and soil amendments applied to each can of soil

ROW NUMBER	AMOUNT APPLIED PER CAN	RATES PER HECTARE	TREATMENT
	grams	*kgm.*	
1			Control
2	200.00	3412	Grass straw
3	200.00	3412	Grass straw
4	200.00	3412	Legume
5	20.00	341	$CaCO_3$
	200.00	3412	Grass straw
6	20.00	341	$CaCO_3$
	200.00	3412	Rice straw
7	3.00	51	$(NH_4)_2SO_4$
	200.00	3412	Rice straw
8	50.00	853	Rice straw ash
9	20.00	341	$CaCO_3$
10	40.00	632	$CaCO_3$
11	3.00	51	$(NH_4)_2SO_4$
12	6.00	101	$(NH_4)_2SO_4$
13	6.00	101	$(NH_4)_2SO_4$
	20.00	341	$CaCO_3$
14	2.50	42	$CaH_4(PO_4)_2$
15	5.00	85	$CaH_4(PO_{42}$
16	4.00	68	KCl
17	8.00	136	KCl
18	4.00	68	KCl
	2.50	42	$CaH_4(PO_4)_2$
19	3.00	51	$(NH_4)_2SO_4$
	4.00	68	KCl
	2.50	42	$CaH_4(PO_4)_2$
20	3.00	51	$(NH_4)_2SO_4$
	2.50	42	$CaH_4(PO_4)_2$
21	0.75	12	Sulfur
22	1.50	25	Sulfur
23	1.50	25	Sulfur
	20.00	341	$CaCO_3$
24	5.00	85	NaCl
25	10.00	170	NaCl

The rice straw, grass straw, and legumes were cut into pieces before they were applied.

Most of the chemical fertilizers used were dissolved in water before they were applied to the soil. The different fertilizers and soil amendments were applied at the same time. No further application was made during the course of this study. A sufficient amount of water was added to each of the cultures to maintain a depth of 3 centimeters during the growing period of the rice plants.

The soil samples for nitrification studies were collected once every two weeks. The samples were taken with a small soil sugar which was specially made for this purpose. The soils collected from treatments A and B were mixed thoroughly and designated as sample (*A*), and the soils from treatments C and D, were likewise mixed thoroughly and the mixture was designated as sample (*B*). The soil samples were air dried, pulverized, and sifted through a one-millimeter sieve.

The method by Fred and Waksman (1928) for nitrification experiments was followed. In the determination of the nitrate content of the various soil samples, the phenoldisulfonic acid method (Emerson, 1925), was used. The amount of nitrate present in the soil was calculated as milligrams of nitrate nitrogen per 100 grams of air-dry soil.

In the denitrification studies the method by Itano and Arakawa (1931), was employed.

DISCUSSION OF RESULTS

Nitrification

An examination of the data in table 1 and illustrated in figure 2 shows that the soils under the various treatments varied in their nitrifying power. The application of fertilizers and soil amendments greatly stimulated the nitrification process in the soil. The greatest amount of nitrate nitrogen content in all of the variously treated cultures was observed two weeks after the application of fertilizers and soil amendments. According to our bi-weekly determinations the increased nitrification was followed by an abrupt decrease in nitrate nitrogen content of the soil. A gradual decrease in nitrification process was followed by a slight but regular fluctuation in the amount of nitrates up to the last sampling.

Denitrification

Considering the averages of results of duplicate determinations on all soil samples, as presented in table 1 and illustrated in figure 2, there were no significant variations in the amount of nitrates which were denitrified or reduced. The greatest loss of nitrates through denitrification was found in treatment 5 where 20 grams of calcium carbonate were added to each can of soil. From the results obtained, it is evident that from the latter part of April to about the end of May, or after the application of fertilizers and soil amendments had been made, denitrification took place. This was shown in the tests by the small quantity of nitrates that was reduced. A correlation between nitrification and nitrate reduction was observed. The writers noted that the increase in the amount of nitrates produced in the soil as a result of nitrification was accompanied by a small percentage of nitrates denitrified.

Judging from the relative percentages, the various soils did not differ significantly in their power to denitrify or reduce the nitrates added. The ability of the different treatments to denitrify occurred in the descending order as follows: 5, 6, 3, 4, 7, 12, 17, 19, 22, 23, 15, 14, 10, 20, 1, 16, 24, 25, 2, 11, 13, 18, 8, 21, and 9.

Growth of rice plants

It may be seen in table 1 that rice plants at four months of age showed a marked growth in height. This was found in treatment 4, with legumes, treatment 12 with ammonium sulfate, and treatment 19 with mixed fertilizers. The poorest growth was exhibited in treatments 21, 22, 23, 24, and 25, and in the control. These results show that the addition of soil amendments did not stimulate the growth of the plants. A good growth of the rice plants was obtained when nitrogenous fertilizers were used. When the soil amendments were inorganic materials, the growth of the plants was not stimulated by the treatment.

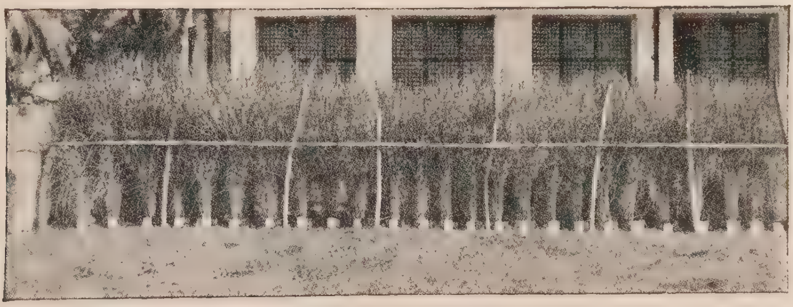

Fig. 3.—Rice plants at booting stage

All the plants were allowed to mature fully and the height of each plant was taken and recorded during the booting stage (fig. 3). Vigorous growth was shown by the plants in treatments 5, 6, 8, and 12. In general, all of the variously treated plants showed a fairly good growth at booting stage. Only the plants in the control pot exhibited a poor growth at this stage.

Yield of grains

With regard to the influence of the different treatments upon the crop, the writers noted that treatment 24, with 5.00 grams of sodium chloride per can of soil, produced the heaviest yield of rice grains. This was followed by treatment 23, with 1.5 grams of sulfur and 20.0 grams of calcium carbonate per can of soil. The yields of the rice in the other treatments were lower than that of the control. The writers are of the opinion that the reason for the lower yields of the other treatments than the control was that the food elements in the soil had been exhausted during the growing period of the plants, and before the rice reached maturity. Another reason seems to be the fact that the plants were planted out of season. They would have matured early had they been planted during the regular planting season. As a consequence of the planting out of season the plants were slow in reaching the booting stage.

A correlation was observed between the yields of grains and straw as influenced by the various treatments. The largest average yield of grain was 35.5 grams by the plants in pot 24 which received an application of 5.0 grams sodium chloride. An amount of 556.25 grams of straw was produced by the plants in pot 19 which received 3.0 grams ammonium sulfate, 4.0 grams potassium chloride, and 2.5 grams of superphosphate.

SUMMARY AND CONCLUSIONS

1. The influence of the application of certain fertilizers and soil amendments on the nitrifying and denitrifying power of Nanhaya clay was studied. Ramai was the rice variety used.

2. The effect of the application of the fertilizers and soil amendments upon the growth of rice was exhibited by the plants in the soil which had been treated with 6.0 grams of ammonium sulfate. At booting stage the rice plants were tallest in the soil treated with 20.0 grams of calcium carbonate and 200.0 grams of dried grass.

3. There was a correlation between the yields of grains and straw as influenced by the different fertilizers and soil amendments. The largest average yield of grains was obtained from plants which had been treated with 5.0 grams of sodium chloride. The largest average yield of straw was shown by the plants treated with 3.0 grams of ammonium sulfate, 4.0 grams of potassium chloride, and 2.5 grams of superphosphate.

4. The greatest nitrification was observed from the early part of April to the later part of May. The largest amount of nitrate

nitrogen was produced in the soil which had been treated with 50.0 grams of rice straw ash.

5. A correlation between nitrification and denitrification was noted in the experiments. When nitrates increased as a result of nitrification, a small amount of reduction of the nitrates was also noted in the denitrification tests.

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TABLE 1

The relation of the nitrifying and denitrifying power of Nanhaya clay, a local alluvial soil, to the growth and yield of rice crop

POT NUMBER	NITRIFICATION		DENITRIFICATION		AVERAGE HEIGHT OF PLANTS		AVERAGE YIELD OF CROP		
	Average	Ratio to Pot 1	Average	Ratio to Pot 1	4 months old	Booting Stage	Palay	Ratio to Pot 1	Straw
	mgm.	*per cent*	*per cent*	*per cent*	*cm.*	*cm.*	*grams*	*per cent*	*grams*
1	1.21	100.00	89.9	100.0	88.75	100.00	31.62	100.00	307.75
2	1.22	100.20	88.3	98.2	100.00	157.50	29.50	93.29	324.50
3	0.63	51.61	92.8	103.0	110.75	163.75	25.00	79.06	397.00
4	0.77	63.61	92.9	103.0	132.50	163.75	16.25	50.22	295.00
5	0.08	6.54	98.7	110.0	122.50	178.75	26.25	83.02	411.00
6	0.66	54.17	98.4	108.1	110.00	171.25	19.37	61.25	400.75
7	1.79	149.40	93.1	103.0	115.25	159.50	7.50	23.72	479.00
8	2.26	186.20	87.0	96.8	102.50	171.25	8.25	25.94	397.00
9	0.07	5.94	84.2	93.7	98.75	161.25	8.50	26.88	310.25
10	1.28	105.50	90.9	101.1	101.25	157.50	9.50	30.04	265.50
11	1.15	95.14	87.8	97.7	120.00	160.00	13.00	41.10	421.75
12	1.04	85.58	92.4	103.0	134.50	166.25	12.50	39.53	445.25
13	0.95	78.07	87.6	97.4	117.50	160.00	11.37	35.95	274.50
14	1.13	93.16	91.0	101.2	102.75	152.75	15.12	47.82	293.00
15	1.62	133.60	91.3	101.5	88.75	146.25	12.12	38.33	299.50
16	1.46	120.40	88.9	98.9	92.50	151.15	16.00	50.60	350.25
17	1.03	84.50	93.1	103.0	95.00	152.50	26.33	81.50	361.75
18	0.08	6.54	87.5	97.3	96.25	148.75	19.75	62.46	297.50
19	0.09	7.42	92.7	103.0	113.75	158.75	23.50	74.32	556.25
20	1.44	118.60	90.0	100.1	105.00	148.75	22.87	72.33	426.25
21	1.46	120.50	86.7	94.6	85.25	150.00	24.82	78.49	239.00
22	1.94	159.90	92.1	103.0	88.75	153.00	28.25	89.34	278.00
23	0.92	75.76	70.6	78.5	87.50	151.25	32.37	100.10	316.25
24	1.05	86.40	88.7	98.7	90.00	157.25	35.50	112.00	334.25
25	0.62	59.57	88.6	98.6	88.75	143.75	31.50	99.78	346.50

DISTILLATION CHARACTERISTICS OF SOME ALCOHOL MOTOR FUELS[1]

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WITH FOUR CHARTS

It is the object of this paper to show the distillation characteristics of some alcohol motor fuels, particularly those which the senior author used in various experiments on alcohol and alcohol-gasoline mixtures. No attempt is made to find the volatility characteristics of a fuel for any desired engine speed and load. A.S.T.M. distillation curves are given to show their relation with actual motor performance under laboratory and field conditions in and around the College of Agriculture, Los Baños, Laguna. Observations on starting, warming up of the engine, and general operating conditions of various makes of cars and trucks were made for a period of more than four years beginning in 1933.

MATERIALS AND METHOD

Dehydrated motor alcohol,[3] gasoline,[4] and mixtures of dehydrated motor alcohol and gasoline in various proportions by volume were used. Two sets, I and II, were studied. In set I, the fuels were prepared in large volumes a few minutes before the laboratory and road tests were conducted. In set II, the mixtures were prepared in the laboratory in amounts just sufficient for distillation experiments.

The distillation apparatus used was obtained from Arthur H. Thomas Company, Philadelphia, U.S.A. The Standard Method D 86-27[5] of the A.S.T.M. for distillation was followed.

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[1] Experiment Station contribution No. 1251. Received for publication July 13, 1938.

[2] Formerly of the Department of Agricultural Engineering.

[3] B-dehydrated alcohol- alcohol purity about 98.5 per cent by volume, denatured with 5 per cent sulfuric ether. Sp. gr. at 15°C. = 0.797.

[4] Ordinary motor gasoline (Shell). Sp. gr. at 15°C. = 0.745.

[5] A.S.T.M. Standards, D 86-27, p. 378 (Part II) 1927. Bureau of Mines Technical Paper 323 B, p. 49, Method 100.13 (1927).

RESULTS AND DISCUSSION

Chart 1 shows the specific gravity of the different fuels for sets I and II. In set I, the line for mixtures containing 30 to 60 per cent gasoline is not so smooth as in set II. The fuels obtained for distillation in set I might not yet have been thoroughly mixed when the samples were taken. In set II where only small volumes were prepared in the laboratory, the samples were thoroughly mixed and blended.

Distillation data and characteristics are shown in tables 1 and 2 and in charts 2, 3, and 4.

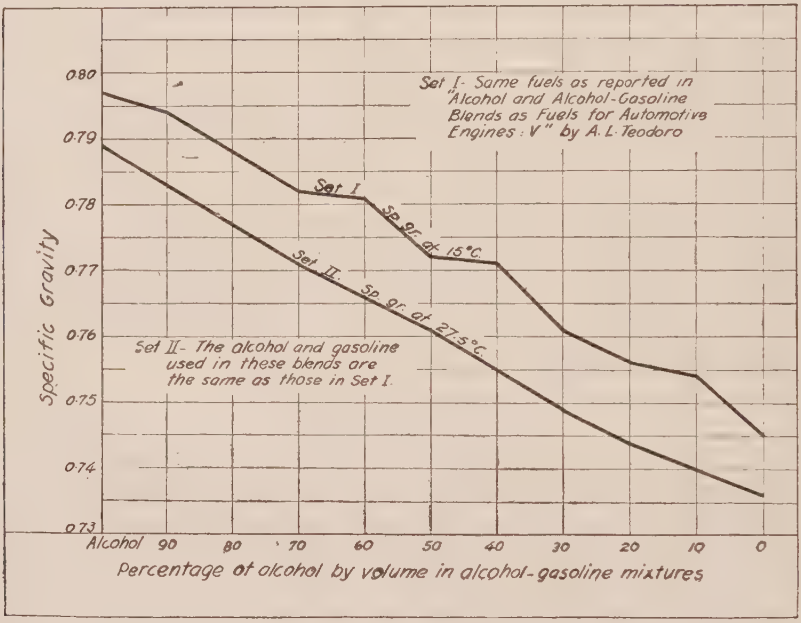

Chart 1.—Relation between specific gravity and fuel mixtures

Brown (1930) points out that 10, 35, and 65 per cent of the distillation curve of a fuel should be low to insure satisfactory starting, warming up, and general performance. The 90-per cent point should not be so low as to indicate a dry-mixture. With many modern cars equipped with heated manifolds and accelerating devices, dry-mixture may mean loss in power or acceleration (Brown, 1930).

Christensen, Hixon, and Fulmer (1933) report that Brown's (1933) figures regarding distillation temperatures are the only published data which are not in complete agreement with those of Ross and Ormandy (1926). Christensen, Hixon, and Fulmer (1933) state that higher initial temperatures were reported by Brown for the alcohol-gasoline mixtures than for the original gasoline. On this particular point the writers' results presented in this paper agree with the findings of Brown. The curve shows that the initial boiling points decrease from about 77°C., using B-dehydrated alcohol, to about 47°C., using gasoline. The gasoline used may be very poor in low boiling constituents, a characteristic not typical of a commercial grade of fuel (Christensen, Hixon, and Fulmer, 1933).

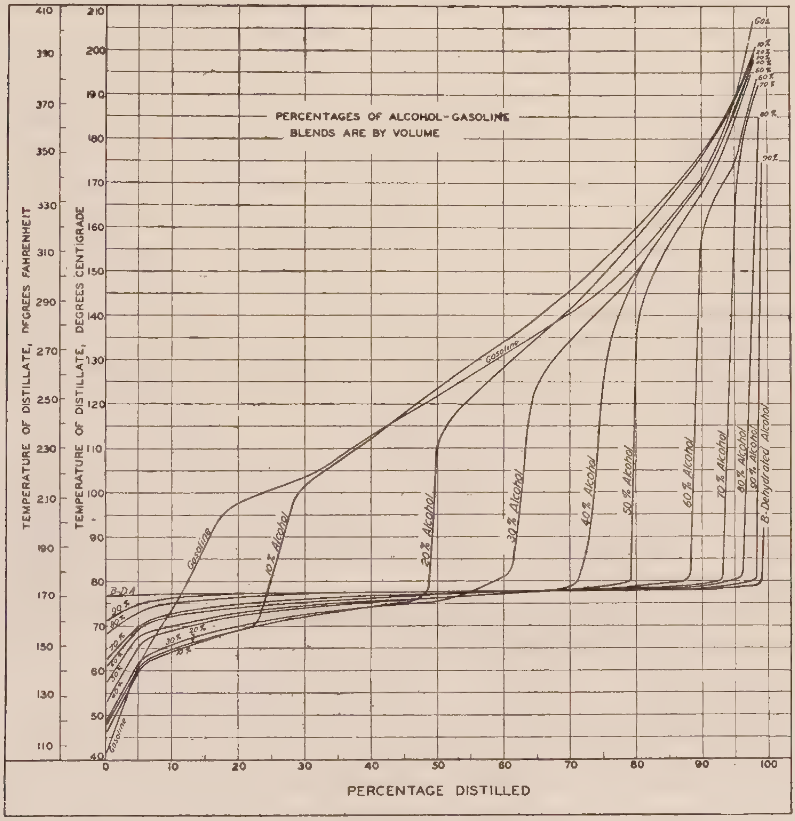

Chart 2.—A.S.T.M. distillation curves for all fuels used in Set I

The temperature of the first 10 per cent distilling is higher in gasoline than in alcohol and alcohol-gasoline mixtures. The temperature gradually increases from a mixture containing 10 per cent gasoline at about 63°C. to straight alcohol at about 78°C. With this fraction used as a relative measure of the loss of the fuel by evaporation during storage, it can be predicted that the storage loss for gasoline will not be as much as for alcohol motor fuels.

Bench tests and field tests showed that no appreciable difference in starting qualities was noted among all the fuels for a warm engine. On rainy days, however, and on cold motors, starting without choking is more difficult with alcohol and with mixtures containing as high as 20 per cent gasoline than with the mixtures containing at least 30 per cent gasoline. The period of choking and the degree of choking vary with the mixtures; they are more for fuel blends containing greater amounts of alcohol. Owing to the wide range of air-fuel ratio in alcohol and alcohol blends, quick starting is possible for almost all the fuels even in cold motors, but because the latent

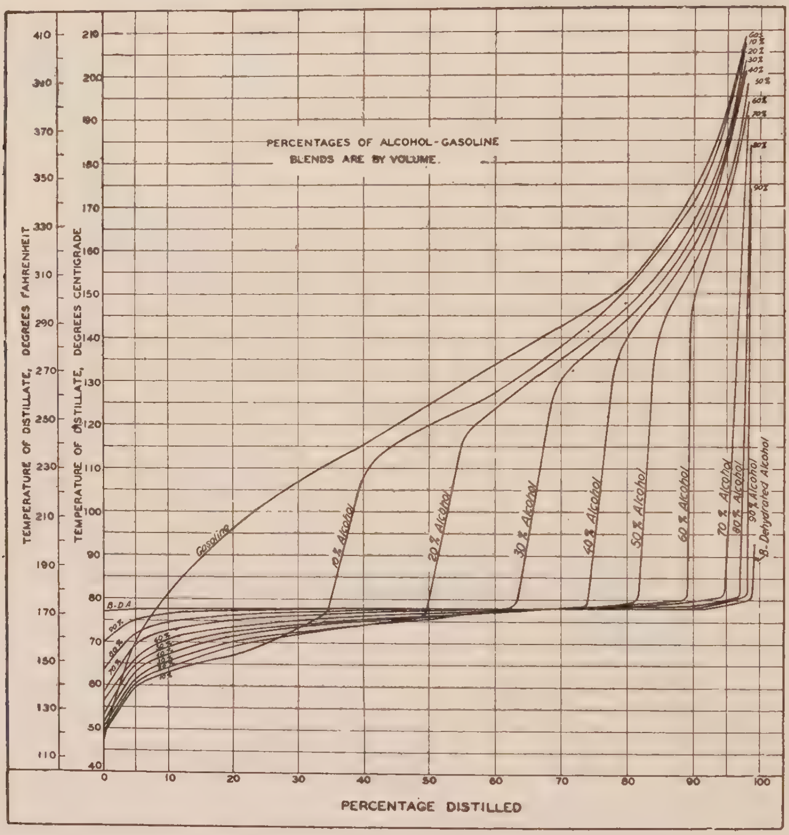

Chart 3.—A.S.T.M. distillation curves for all fuels used in set II

heat of alcohol is high, flame propagation can not continue in some mixtures unless partial choking is extended.

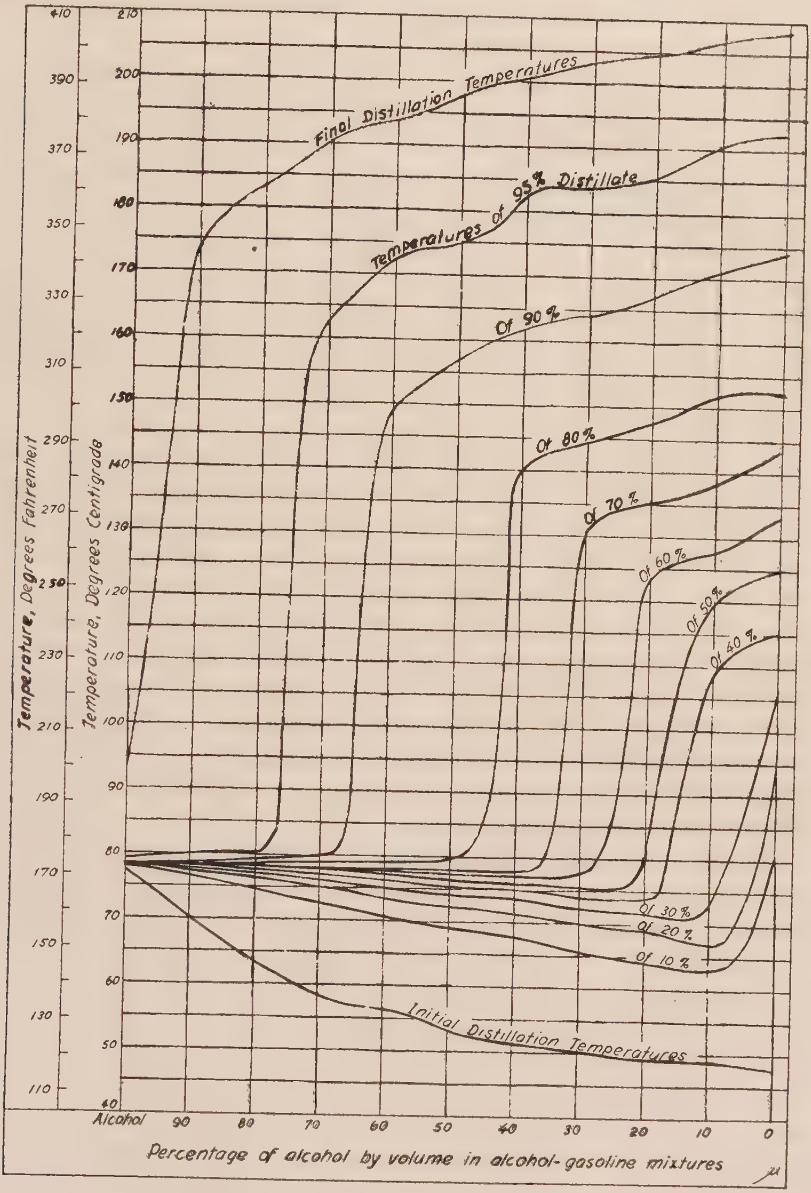

Chart 4.—Relation between temperature of A.S.T.M. distillation and fuel mixtures

The warming up periods differ in different engines depending upon the materials used, number of cylinders, compression ratio, preheating devices, and the designs and adjustment of the carburetion and ignition systems. The greater the amount of alcohol present in the mixture, the longer is the time necessary for warming up before a desired power is obtained.

The temperature of the first 30 per cent distilling is much lower for alcohol and for alcohol blends than for gasoline. The 30 per cent point for gasoline is about 107°C. while for alcohol and alcohol-gasoline blends, the temperature decreases slightly from about 78°C. to 72°C. Christensen, Hixon, and Fulmer (1933) remarked that the greater volatility of this fraction undoubtedly accounts for the better acceleration of alcohol blends, particularly noticeable in cold weather. The senior author's experience in his numerous tests showed that better acceleration was more in evidence during the cool months of December, January, and February than in April and May when the weather was usually hot.

The performance of the hot motor under bench and road conditions is generally smoother when the amount of alcohol present in the fuel is higher. The temperature of distilling of the first 60 per cent is low and is nearly the same for mixtures containing at least 30 per cent alcohol. The 60 per cent point for gasoline is about 133°C., and for the other fuels, about 78°C. Under the conditions in which the bench and road tests were conducted, the acceleration obtained for mixtures containing 15, 20, and 30 per cent alcohol was slightly slower than for gasoline and for mixtures containing 5 and 10 per cent alcohol. No appreciable difference was noted in the performance of a hot motor when gasoline and mixtures containing 5 and 10 per cent alcohol were used.

The temperature of distillation of the last 10 per cent is about 174°C. for gasoline and about 79°C. for the fuels containing at least 70 per cent alcohol. Brown (1933) reported that a very low temperature at the 90 per cent distilling may cause a decrease in power and in acceleration. Experience showed that cars[6] using nearly straight motor alcohol lost power and acceleration on climbing hills, especially if the operator is not skillful in manipulating the throttle when maximum power is desired. In bench tests where the engine is run at constant speed for a certain load, this difficulty is not encountered. A high compression engine that is adjusted properly to run on a certain alcohol-gasoline mixture or on nearly straight alcohol motor fuel, rarely loses power and acceleration if run by a skillful operator. Most of the modern cars and trucks show much better performance on hills when run on alcohol or on alcohol-gasoline mixtures than on gasoline alone.

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[6] Compression ratio from 4.8:1 to 5.4:1.

SUMMARY

Higher initial temperatures were obtained for the alcohol and alcohol-gasoline mixtures than for the original gasoline.

The temperatures of the first 10, 30, and 60 per cent distilling were lower in alcohol and in alcohol-gasoline mixtures than in gasoline. Under Philippine conditions, satisfactory starting and smooth performance were observed in a hot motor run on alcohol and on mixtures. On rainy days a longer warming up period and slightly more choking are necessary on mixtures containing a large proportion of alcohol than on gasoline.

A slight loss in power and in acceleration was obtained in climbing hills on a full load when the motor used is not yet very warm, the engine not well adjusted for the fuel used, the operator not very skillful, the compression ratio of the engine low, and the general engine design not the best desired for alcohol and for mixtures containing less than 10 per cent gasoline. The loss in acceleration and power may be due to the low temperature of the last 10 per cent distilling.

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TABLE 1

Data of distillation of alcohol, gasoline, and alcohol-gasoline blends. Mixtures are by volumes. (Set I—The dehydrated alcohol was obtained from La Tondeña)

FUELS	SPECIFIC GRAVITY 15°C./15°C.	INITIAL BOILING POINT	TEMPERATURE OF DISTILLATE AT CERTAIN DEFINITE VOLUMES IN CUBIC CENTIMETERS											END POINT	VOLUME IN CUBIC CENTIMETERS		
			5	10	20	30	40	50	60	70	80	90	95		Sudden rise of temperature at this volume	Distillate	Residue
		°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.			
B-Dehydrated alcohol		76.7	77.0	77.2	77.2	77.3	77.5	77.5	77.7	77.7	77.8	78.0	78.7	88.0			
		76.8	77.1	77.2	77.2	77.3	77.5	77.5	77.6	77.7	77.8	78.0	78.7	96.2			
Average	0.797	76.8	77.1	77.2	77.2	77.3	77.5	77.5	77.7	77.7	77.8	78.0	78.7	92.1	99.0	99.2	0.6
90 per cent alcohol		72.0	75.0	76.2	77.0	77.3	77.5	77.7	77.9	78.0	78.0	78.5	79.0	175.2			
		71.2	75.1	76.2	77.0	77.2	77.5	77.7	77.9	78.0	78.1	78.8	79.9	171.0			
		71.0	75.1	76.2	77.0	77.3	77.7	77.9	78.0	78.0	78.0	78.6	79.7	176.0			
Average	0.794	71.4	75.1	76.2	77.0	77.3	77.6	77.8	77.9	78.0	78.0	78.6	79.5	174.7	98.0	98.9	0.9
80 per cent alcohol		68.0	73.5	75.0	76.0	77.0	77.3	77.8	77.9	78.0	78.2	79.0	80.5	184.2			
		68.0	73.3	75.0	76.0	77.0	77.2	77.6	77.9	78.0	78.2	79.0	80.5	184.5			
		68.8	73.3	74.9	76.2	77.0	77.2	77.7	77.9	78.0	78.2	79.0	80.5	185.2			
Average	0.788	68.3	73.4	75.0	76.1	77.0	77.3	77.7	77.9	78.0	78.2	79.0	80.5	184.6	95.8	98.7	1.2
70 per cent alcohol		63.0	70.1	72.8	75.0	76.0	76.8	77.0	77.6	78.0	78.4	79.5	168.0	191.5			
		62.3	70.2	72.8	75.0	76.0	76.6	77.0	77.4	78.0	78.6	79.6	166.0	191.6			
		63.0	70.2	72.9	75.0	76.0	76.8	77.0	77.6	78.0	78.5	79.5	167.0	191.6			
Average	0.782	62.8	70.2	72.8	75.0	76.0	76.7	77.0	77.5	78.0	78.5	79.5	167.0	191.6	92.7	98.5	1.3

TABLE 1 (continued)

FUELS	SPECIFIC GRAVITY 15°C./15°C.	INITIAL BOILING POINT	TEMPERATURE OF DISTILLATE AT CERTAIN DEFINITE VOLUMES IN CUBIC CENTIMETERS											END POINT	VOLUME IN CUBIC CENTIMETERS		
			5	10	20	30	40	50	60	70	80	90	95		Sudden rise of temperature at this volume	Distillate	Residue
		°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.			
60 per cent alcohol		61.0	70.1	72.0	74.2	75.3	76.2	77.0	77.5	78.0	78.9	158.0	171.0	193.0			
		61.0	70.0	72.0	74.0	75.2	76.1	76.9	77.3	78.0	78.8	159.8	177.6	194.0			
		61.2	70.1	72.0	74.0	75.3	76.1	77.0	77.4	78.0	78.9	160.0	176.4	194.0			
		61.1	70.1	72.0	74.2	75.4	76.2	77.1	77.6	78.0	79.0	160.2	174.2	194.0			
Average	0.781	61.1	70.1	72.0	74.1	75.3	76.2	77.0	77.5	78.0	78.9	159.5	174.8	193.8	88.0	98.3	1.3
50 per cent alcohol		56.7	67.5	69.8	72.8	74.5	75.5	76.3	77.2	78.0	137.0	168.1	184.4	194.0			
		56.7	67.7	69.8	72.7	74.2	75.3	76.2	77.1	78.0	136.2	168.0	184.2	195.0			
		58.7	68.0	69.9	72.7	74.2	75.3	76.2	77.1	78.0	135.5	167.4	185.2	195.2			
		57.1	67.6	69.8	72.8	74.5	75.6	76.4	77.2	78.0	136.0	167.5	184.6	195.0			
Average	0.772	57.3	67.7	69.8	72.8	74.4	75.4	76.3	77.2	78.0	136.2	167.8	184.6	194.8	79.0	97.3	1.3
40 per cent alcohol		53.0	65.5	69.0	72.3	74.0	75.1	76.0	77.0	78.8	149.3	171.3	186.0	197.3			
		53.4	65.6	69.0	72.4	74.0	75.2	76.2	77.1	79.0	149.0	169.3	185.5	197.5			
		52.5	66.0	69.0	72.3	74.0	75.2	76.2	77.2	79.1	150.0	170.6	186.0	197.8			
Average	0.771	53.0	65.7	69.0	72.3	74.0	75.2	76.1	77.1	79.0	149.4	170.4	185.8	197.5	71.0	98.0	1.3
30 per cent alcohol		50.0	62.0	66.0	70.1	72.8	74.1	75.7	78.4	135.0	150.1	170.0	184.8	192.0			
		49.2	62.1	66.0	70.0	72.7	74.2	75.5	79.0	133.8	149.5	170.3	187.3	201.0			
		48.5	62.1	65.8	69.8	72.5	74.1	75.4	80.0	135.0	148.1	170.1	186.8	200.6			
Average	0.761	48.9	62.1	65.9	70.0	72.7	74.1	75.5	79.1	134.6	149.2	170.1	186.3	197.9	61.0	97.8	1.2

TABLE 1 (continued)

FUELS	SPECIFIC GRAVITY	INITIAL BOILING POINT	TEMPERATURE OF DISTILLATE AT CERTAIN DEFINITE VOLUMES IN CUBIC CENTIMETERS											END POINT	VOLUME IN CUBIC CENTIMETERS		
			5	10	20	30	40	50	60	70	80	90	95		Sudden rise of temperature at this volume	Distillate	Residue
		°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.			
20 per cent alcohol		47.0	61.2	64.3	69.2	72.0	74.0	112.1	128.0	142.0	158.0	176.8	189.8	198.0			
		48.8	61.2	64.6	69.0	72.0	74.0	111.0	128.7	141.2	158.0	175.8	188.0	199.3			
		48.5	61.2	64.8	69.0	72.0	74.2	111.0	128.8	142.0	157.7	176.3	189.3	199.6			
Average	0.756	48.1	61.2	64.6	69.1	72.0	74.1	111.4	128.5	141.7	157.9	176.3	189.0	199.0	47.9	98.0	1.3
10 per cent alcohol		46.0	60.3	64.4	69.0	101.0	111.2	123.0	133.0	144.2	158.3	175.7	187.8	201.7			
		46.2	60.2	64.1	69.0	101.0	112.7	124.0	135.0	147.0	161.1	178.0	190.0	201.0			
		46.1	60.6	64.5	69.0	103.0	112.8	124.0	133.6	145.8	160.8	178.0	190.1	200.7			
Average	0.754	46.1	60.4	64.3	69.0	101.7	112.2	123.7	133.9	145.7	160.1	177.2	189.3	201.1	22.5	98.2	1.2
Gasoline		41.8	62.0	73.0	97.5	103.2	113.1	122.0	131.3	141.7	153.4	171.0	187.7	207.0			
		42.0	62.0	74.0	98.1	103.5	113.2	122.0	131.0	140.0	153.6	171.2	189.7	206.0			
		42.0	62.5	74.0	98.0	103.8	113.2	122.0	131.8	140.5	153.2	171.5	189.6	207.0			
Average	0.745	41.9	62.2	73.7	97.9	103.5	113.2	122.0	131.4	140.7	153.4	171.2	189.0	206.7	—	97.6	1.4

TABLE 2

Data[a] *of distillation of alcohol, gasoline and alcohol-gasoline blends. (Set II—Fuels used in the mixtures are the same as those used in Set I)*

FUELS	SPECIFIC GRAVITY $\frac{27.5°C.}{27.5°C.}$	INITIAL BOILING POINT	TEMPERATURE OF DISTILLATE AT CERTAIN DEFINITE VOLUMES IN CUBIC CENTIMETERS											END POINT	VOLUME IN CUBIC CENTIMETERS		
			5	10	20	30	40	50	60	70	80	90	95		Sudden rise of temperature at this volume	Distillate	Residue
		°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.			
B-Dehydrated alcohol	0.789	77.0	77.5	77.6	77.8	77.8	77.8	77.9	77.9	78.0	78.0	78.1	79.0	93.0	98.6	99.0	0.4
90 per cent alcohol	0.783	69.8	75.0	76.3	77.2	77.5	77.8	77.8	77.9	78.0	78.0	78.4	79.8	174.0	98.0	98.2	0.5
80 per cent alcohol	0.777	63.4	72.0	74.3	76.0	76.8	77.3	77.9	78.0	78.1	78.3	78.9	80.0	183.5	96.9	98.7	0.7
70 per cent alcohol	0.771	58.2	69.5	72.5	75.0	76.0	76.9	77.4	77.8	78.1	78.7	79.8	162.5	190.5	94.5	98.1	0.9
60 per cent alcohol	0.766	56.2	66.0	70.6	73.4	75.0	76.0	76.9	77.4	78.0	78.8	149.2	172.5	193.6	88.9	98.0	0.8
50 per cent alcohol	0.761	53.1	64.8	68.7	72.3	74.0	75.2	76.2	77.2	77.8	79.4	157.1	175.0	197.8	81.5	98.0	1.0
40 per cent alcohol	0.755	51.3	63.1	67.1	71.3	73.5	75.0	76.0	77.1	78.0	140.2	161.9	183.1	200.7	73.9	97.6	1.2
30 per cent alcohol	0.749	50.2	61.5	65.3	70.0	72.2	74.0	75.5	77.6	130.9	144.2	164.0	183.5	203.1	62.9	97.7	1.3
20 per cent alcohol	0.744	49.0	60.5	64.0	69.0	71.7	74.0	81.3	123.8	135.2	147.5	167.2	185.7	204.5	49.5	97.3	1.3
10 per cent alcohol	0.740	48.8	59.7	63.0	67.0	73.5	108.5	120.0	127.5	138.3	151.9	171.1	190.8	206.8	34.5	97.8	1.2
Gasoline	0.736	47.6	70.3	81.4	96.5	107.0	115.3	125.0	133.5	143.8	152.2	174.0	192.5	208.3	—	97.8	1.4

[a] Values given are averages.

FOUNDATION OF AGRICULTURE OF JAPAN THROUGH RESEARCH, EXPERIMENTATION, AND EDUCATION[1]

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In the present article, the author wishes to give an outline of agriculture in Japan:—how it was founded, how it is developing, and what makes it prosperous without any fear of future degeneration.

Japan is an island empire 1.3 times larger than the Philippine Islands (Japan proper, 382,545 square kilometers; Philippines, 296,373 square kilometers), but she has to sustain a population nearly 5.5 times as large as the Philippines (Japan proper, 71,252,800 in 1937; Philippines, 13,099,405 in 1935).

Although the advance of the manufacturing industry in Japan is very great and the export of Japanese articles is ever increasing, still Japan remains an agricultural country, feeding all her population by her own produce. Rice is the staple food in Japan as in most of the tropical countries, and its annual production amounts to nearly 2,550,000,000 yen (Philippines, about 200,000,000 pesos), and this figure is nearly as big as the total Japanese production of staple goods, except silk, and as big as the total chemical and mechanical production of Japan combined.

Production of other food materials amounts to about 78,000,000 yen, and the total amount produced in Japan is nearly 3,330,000,000 yen worth of food products which sustain the entire population of the mainland and colonies.[2]

Now you will see that the foundation of Japan is entirely different from a power like England. The mainland of Great Britain is about the same as Japan in area and population, but she has to import 100,000,000 pounds worth of grain, meat, and dairy products. The British raise these food materials in Canada, Australia, New Zealand, and her other colonies all of which are at a great distance, and she must always feel safe in bringing in these foodstuffs to her mainland. Japan has no worry at all about the food materials she consumes. The agriculture of Japan is steady enough to feed the nation without any fear of getting short even in war time.

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[1] An excerpt from a lecture given before the Convocation assembly in the College of Agriculture, University of the Philippines. Miscellaneous contribution No. 20.

[2] Total area of colonies 298,416 sq. km., with additional population of about 30,000,000 people.

In other words, although the progress of the manufacturing industry of Japan has been very rapid in recent years it has brought no threat to Japanese agriculture, unlike the industrial progress of England which killed her home production of basic agricultural crops and essential food resources. What caused such a big difference between these two countries, so closely resembling each other in general conditions, needs explanation.

RESEARCH, EXPERIMENTATION, AND EDUCATION

It has been suggested quite often that Japan should give up the effort to develop her agriculture and devote the energy of the nation to manufacture and trade. Notwithstanding this suggestion, agriculture has been encouraged both strongly and effectively in Japan proper, as well as in the colonies (chiefly Korea and Formosa) to help the home production. The ideal of the nation for agriculture has always been high. To promote it, a big force in research, experimentation, and education has been established, with university laboratories to create the fundamental principles of agricultural science in Japan. There are federal experiment stations to work out the scientific processes of agricultural production and federal higher agricultural colleges to secure men who hold the leadership in the promotion of new phases of rural production. There are many prefectural agricultural experiment stations to try out the program of promotion projects of the central government and work upon the suitable technique in bringing the local production to the highest standards. There are many local agricultural high schools run by prefectural governments to turn out scientific farmers and well informed agricultural workers in various rural organizations. Considerable numbers of rural young men's schools affiliated with primary schools are organized by law throughout Japan to give facility to rural inhabitants who cannot afford to receive vocational agricultural education, but need to be trained as efficient and faithful farmers. Besides these, private but strongly patriotic training schools of young farmers are actively working to make local leaders of agricultural provinces. Agricultural societies (rural promotion associations) and coöperative agricultural associations, which are highly developed in Japan, also give courses in agriculture in schools and seminaries to bring up the youth to fit in these lines. Teachers' schools of all of these agricultural educational organizations are also complete, and spiritual, not technical, agricultural training schools are also seen in many places. Many temporary agricultural courses are given by various organizations, including governmental departments, and these help to bring close contact between industrial and research bodies to strive toward the same object.

DETAILS OF THE EDUCATIONAL ORGANIZATION

Five imperial universities out of seven, run exclusively by the endowments of the federal government, have faculties of agriculture distributed in departments as shown in table 1.

There are about one hundred and fifty independent institutes in these universities specialized in all lines of agricultural subjects, with professors, assistant professors, assistants, and various grades of technical employees, spending roughly 1,500,000 yen for scientific investigations alone in laboratories and seminary rooms. Series of technical publications are issued and distributed all over the world: memoirs, journals, contributions, communications, essays, occasional papers, and so on, amounting to at least 1,500 titles a year. The university to us is a highly research organization, and teaching is always of secondary importance.

There is one single-line university in agriculture (378 students) run by the Agricultural Society of Japan, a promotion body headed by H.I.H. Prince Kan-in, and eighteen Federal Higher Agricultural Colleges, specialized in lines given in table 2.

Other agricultural educational organizations are roughly figured as follows:

Agricultural high schools (colonies omitted)	358
(Specialized in agriculture, 302; forestry, 25; agriculture and forestry, 36; sericulture, 4; sericulture and filature, 14.)	
Expenditure in 1936	7,954,172 yen
Number of students in 1935	75,212
Number of teachers in 1935	4,494
Teachers' schools for agricultural high schools, one formerly affiliated with Tokyo Imperial University now independent, several others affiliated with the federal colleges of agriculture.	
Teachers' schools for rural young men's schools mostly affiliated with the prefectural agricultural high schools	48 for men 4 for women

Mainland only

Expenditure in 1936	358,707 yen
Number of students in 1936	1,325
Number of regular teachers in 1936	283
Number of temporary teachers in 1936	744

Rural Young Men's Schools (mostly affiliated with primary schools) in 1936

Mainland only

Number of schools	16,810
Number of students	11,135,206
Number of teachers	176,673
Expenditure	29,209,574 yen

Training school of young farmers (colonies omitted)

Discipline courts for farmers	29
Spiritual training schools for farmers	50

Schools and permanent agricultural seminaries run by agricultural societies and associations (mainland only).

Schools organized by prefectural agricultural societies	9
Schools organized by country agricultural societies	23
Schools organized by city or village agricultural societies	3
Seminaries organized by prefectural agricultural societies	38
Seminaries organized by country agricultural societies	77
Seminaries organized by city agricultural societies	5
Seminaries organized by village agricultural societies	60
Seminaries organized by confederated coöperative agricultural associations of Japan	3
Seminaries organized by local cooperative agricultural associations (for women)	many
Seminaries organized by local cooperative agricultural associations for special subjects	about 4 courses in many places
Annual touring classes of farmers, enrollment for 1936	4,749 persons

These will show how extensive the rural educational activities are, and this is really the man-power which brought such great success to Japanese agriculture.

AGRICULTURAL EXPERIMENTATION

Agricultural experimentation work is carried out in both federal and prefectural agricultural and sericultural experiment stations, as well as in those specializing in horticulture, tea culture, and animal husbandry. The outline of these is briefly summarized as follows:

Federal organizations

Federal Agricultural Experiment Station at Nishigahara, Tokyo, with two sub-stations in Konosu and Omagari.

Federal Horticultural Experiment Station at Okitsu, Shidzuoka Prefecture.
Federal Tea Industry Experiment Station at Kanaya, Shidzuoka Prefecture.
Federal Livestock Experiment Station at Miyako-mura, Chiba Prefecture.
Federal Stockyard in Toyohira-machi, Hokkaido.
Federal Veterinary Research Station at Nishigahara, Tokyo.
Federal Poultry Farms at Aomori, Omiya, Harima, Okazaki, and Higo.
Federal Sericultural Experiment Station at Suginamimura, near Tokyo.
Federal Silk Conditioning Laboratory in Yokohama.
Federal Horse Breeding Station, two central, fifteen local.

Expenditures of these federal experiment stations are about 3,500,000 yen a year.

Local organizations

Agricultural Experiment Station of Hokkaido with four sub-stations.
Agricultural Experiment Station of Okinawa (Lutchu) with sugar substation.
Agricultural Experiment Station of Korea, Suigen, Chosen.
Department of Agriculture of Central Research Institute at Taihoku, Formosa.

Prefectural agricultural experiment stations	45
Prefectural tea industry experiment stations (Saitama, Kumamoto, and Kyoto)	3
Prefectural apple experiment station (Aomori)	1
Prefectural sugar experiment station (Kagoshima)	1
Prefectural sericultural experiment stations (with 25 sub-stations)	48
Prefectural livestock farms	59
Prefectural sheep farms	5
Prefectural grain inspection stations	111
Prefectural sericultural inspection stations	45
Prefectural silk cocoon inspection stations	35

The expenditure for these works is more than 15,000,000 yen a year.

ORGANIZED AGRICULTURAL ACTIVITIES

The agricultural activities in Japan are highly organized. The promotion society of agriculture has a long history of development and now it has reached the stage wherein all farmers are united under a compulsory coöperative organization called "Nokwai", or agricultural society. It is not a business organization, but rather a promotion society in which the members help each other for the betterment of rural legislation, farm management, marketing of farm products, cultural technique, and so on. Every farmer belongs to a city or village agricultural society and pays the fee collected by the revenue officers of each municipality. County agricultural societies are also run by country revenue; prefectural agricultural societies, by prefecture revenue; and all societies are confederated into the central organization called "Imperial Agricultural Society". The numbers and expenditures of these farmers' bodies are as follows:

Central or "Teikoku" (Imperial) Agricultural Society	1	251,950 yen	(1937)
Prefectural Agricultural Society	47	3,842,040 "	(1936)
Country Agricultural Society	543	8,057,545 "	(1935)
City and village Agricultural Society	9,741	21,284,513 "	(1935)

Coöperative business organizations in agriculture in Japan are enormous in number, having a confederated system uniting them into the "Chuokwai", or Central Society of Productive Associations. The work is summarized below:

(Figures as of 1935)

Financial associations	12,931	(These figures cover agriculture, forestry, mechanics arts, commerce and fishery, and not agriculture alone.)
Selling associations	11,905	
Supply associations	12,588	
Utilization associations	9,873	
Financial associations within the territory of business towns	271	
Agricultural storehouses	4,303	

Total number of associations in combination	14,017
Membership of agricultural associations	4,103,600
Total paid stock for the activity to all industrial associations	260,482,626 yen

(No figure is available for agriculture alone)

The activity of coöperative associations has a long history and no detailed account can be given here.

There is a great deal of money spent for farm relief in recent years, chiefly to save the farmers stricken by climatic damage or by economic depression. Nearly 27,697,884 yen was spent by the central government, and about 50 million yen by the prefectural governments.

CONCLUSION

The great agricultural activity of Japan is unquestionable aided by the policy of the Japanese government to bring it to as high a level as possible. The encouragement is centered upon three phases, namely, research, experimentation, and education. From organized activity of farmers and adequate governmental aid to improve the farm conditions, the agricultural production of Japan is making rapid progress, especially in food production which is the most steadfast of all productive industries of Japan. It is however, true that the raw plant materials, except tea and sugar, are not much produced, and an enormous quantity of these articles must be imported mostly from tropical and subtropical countries to keep Japanese manufactures going. The author finds a great opportunity for the Philippines to supply Japan with more tropical products, and in that way accelerate her agricultural activity. Such articles are cotton, rubber, timber, wood pulp material, oil seeds, hard fibers, other textile materials, and certain medicinal and aromatic substances. Closer coöperation of these two agricultural countries, situated so near each other, should be brought about by increasing the mutual understanding and by arousing the spirit of mutual help, which will ultimately benefit both countries.

(*Communications from the Horticultural Institute, Taihoku Imperial University, No. 75.*)

TABLE 1

Distribution in departments of faculties of agriculture of five imperial universities

UNIVERSITIES	AGRONOMY	AGRICULTURAL CHEMISTRY	FORESTRY	AGRICULTURAL ENGINEERING	AGRICULTURAL ECONOMICS	AGRICULTURAL BOTANY	VETERINARY MEDICINE	ANIMAL HUSBANDRY	FISHERY
Tokyo Imperial University	127	167	136	47	93	—	79	—	29
Kyoto Imperial University	73	74	66	31	99	23	—	—	—
Kyushu Imperial University	108	103	32	—	—	—	—	—	—
Hokkaido Imperial University ..	75	75	42	—	—	16	—	65	—
Taihoku Imperial University ...	13	9	—	—	—	—	—	—	—
	396	428	276	78	192	39	79	65	29

(Figures as of May, 1936)

TABLE 2

Lines of specialization of Federal Higher Agricultural Colleges

COLLEGE STUDENT GROUPS	AGRONOMY	AGRICULTURAL CHEMISTRY	FORESTRY	AGRICULTURAL ENGINEERING	AGRICULTURAL ECONOMICS	HORTICULTURE	VETERINARY MEDICINE	ANIMAL HUSBANDRY	SERICULTURE	SILKWORM PROPAGATION	MULBERRY CULTURE	FILATURE	SILK WEAVING
Morioka Norin	101	75	88	—	—	—	87	—	—	—	—	—	—
Kagoshima Norin	122	50	84	—	—	—	—	—	68	—	—	—	—
Uyeda Sansi	—	—	—	—	—	—	—	—	93	—	—	97	58
Tokyo Sansi	—	—	—	—	—	—	—	—	110	—	52	110	—
Kyoto Samsi	—	—	—	—	—	—	—	—	106	73	—	98	—
Tottori Nogyo	118	117	—	—	—	—	—	—	—	—	—	—	—
Mie Norin	122	—	121	112	—	—	—	—	—	—	—	—	—
Utsunomiya Norin	134	—	81	—	—	—	—	—	—	—	—	—	—
Gifu Norin	122	93	87	—	—	—	—	—	—	—	—	—	—
Miyazaki Norin	116	—	89	—	—	—	—	89	—	—	—	—	—
Chiba Engei	—	—	—	—	—	166	—	—	—	—	—	—	—
Tokyo Norin	136	—	116	—	—	—	—	—	—	—	—	—	—
Hokkaido University College	100	—	95	—	—	—	106	—	—	—	—	—	—
Tokyo S. 1. University College [a]	506	206	—	—	—	—	—	—	—	—	—	—	—
Tokyo Jui [a]	—	—	—	—	—	—	482	—	—	—	—	—	—
Azabu Jui [a]	—	—	—	—	—	—	333	—	—	—	—	—	—
Taihoku University College	91	—	59	—	—	—	—	—	—	—	—	—	—
Suigen Norin	119	68	—	—	—	—	39		—	—	—	—	—

[a] Colleges not federal.

(Figures as of May, 1936. Besides these, there is one fisheries college in Tokyo.)

THE VALUE OF FIRST GENERATION HYBRIDS OF NATIVE YELLOW FLINT CORN[1]

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Of the Department of Agronomy

WITH FOUR TEXT FIGURES

The increase in vigor, as shown by size and vegetative productiveness of the first generation plants resulting from fertile crosses, was one of the first experimental results observed by the early plant hybridizers. The fundamental nature of this phenomenon was discovered in corn (Shull, 1909) and has since then played a definite rôle in the improvement of this crop. The usual procedure in the utilization of this phenomenon in the improvement of corn yield is first to develop pure lines through successive inbreeding and then recombine the lines in single or double crosses to produce the first generation hybrid seed which is utilized in commercial planting. This method calls for the use of F_1 hybrid seeds every year, the parents of which are individually maintained as a pure line. The crossing of corn varieties without previous selection and inbreeding is a practicable way of utilizing hybrid vigor for increased production. The successful utilization of this hybrid vigor for increased yield will, of course, vary with the kind of combination made. Obviously, there is a great advantage in using varieties or strains which are well adapted to the region. Native Yellow Flint corn is the best established variety in the country and is represented by several regional or geographical strains. Because the seeds are secured from a small number of ears from different farms, these strains should be highly inbred. The first generation crosses between these regional strains, however, have not as yet been studied. If hybrid vigor, or heterosis, be manifested in these crosses, a certain amount of improvement in yield can be secured without previous artificial inbreeding work.

Review of literature

The literature dealing with tests of productivity of first generation hybrids between more or less related forms of maize is voluminous. Since it is impossible to review all of the experiments, only those on first generation crosses between standard corn varieties and geographical types will be considered.

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[1] Experiment Station contribution No. 1252.

Collins (1910a) studied the results of 16 crosses made in 1908 between diverse types of corn from widely separated localities. It was found in comparing the yields of F_1 crosses and parental varieties that the average percentage of increase of hybrids over parents amounted to 53 per cent.

Collins (1910b) using 6 varieties of sweet corn, studied the yields of 10 different combinations and found that 80 per cent exceeded the average of the parents. The average yield of all the hybrids compared with the average of the parental varieties showed an increase of 57 per cent.

Jones and his collaborators (1916) reported that out of 50 first generation crosses of commercial corn varieties, 88 per cent yielded more than the average of the parents, and of these, 66 per cent yielded more than either parent.

Hayes and Olson (1917) reported that the first generation crosses between standard Minnesota corn varieties yielded an average of from 5 to 66 per cent more than the better parent.

In the Philippines, the significance of first generation hybrids was first noted by Mendiola (1914), who crossed dent and flint varieties and found that the first generation hybrid gained in length and diameter of ear, number of kernels per row, as well as in weight, length, and width of kernels. Increase in yield of the first generation hybrid over either parent ranged from 7 to 63 per cent.

Marquez (1917) crossed some local and introduced corn varieties and recorded that the first generation crosses exceeded either parent by 2 per cent and the average of the two parents by 11 to 21 per cent.

Objects of the present work

This work was undertaken with the following objects: (1) to determine the relative value of the regional strains of Native Yellow Flint corn and the first generation crosses between these strains in increasing corn yields; and (2) to find whether the increased yields resulting from hybrid vigor are sufficiently great to pay for the added cost of producing the first generation hybrid seed.

Time and place of the work

The experiments were conducted in the Experiment Station fields of the Department of Agronomy and in the fields of the Department of Animal Husbandry, College of Agriculture, from May, 1936, to September, 1937, a period of seventeen months.

MATERIALS AND METHODS

Variety and strains

Four strains of Native Yellow Flint corn were used in this study. These were arbitrarily designated as Abra, College, Pangasinan, and Nueva Vizcaya. The Abra, Pangasinan, and Nueva Vizcaya strains were named after the province from which the corn was imported. The College strain was named after the College of Agriculture in which it is grown commercially. The grains of these different strains of Native Yellow Flint corn are all yellow. They differ to some extent in the size and shape of the ears and in their stand in the field. The College strain possesses a long cob with shallowly

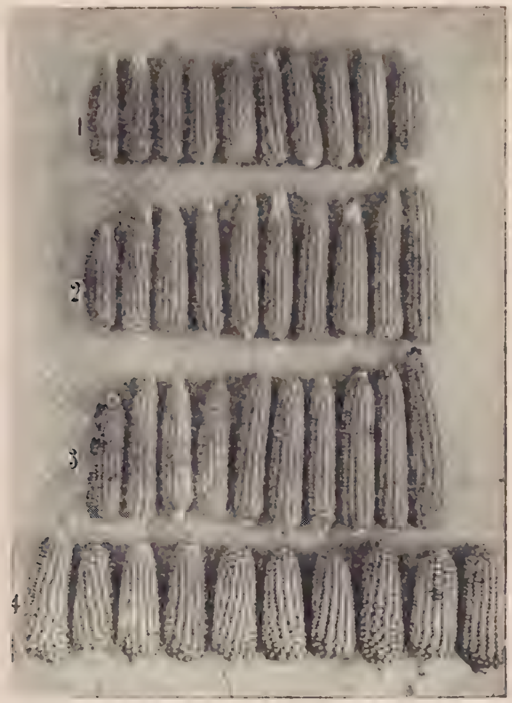

Fig. 1.—Showing strains of Native Yellow Flint corn used in the experiments: (1) Nueva Vizcaya strain, (2) College strain, (3) Pangasinan strain, and (4) Abra strain

set kernels. It is grown on a commercial scale in the College of Agriculture and around Los Baños. The Pangasinan strain is very similar to that of the College in size and grains and ears. The Nueva Vizcaya, a representative of the strain grown in Nueva Vizcaya, possesses a short and slender cob. The grains are somewhat smaller in size than either the College or Pangasinan strains. The color of the grains is like those of the College strain. The Abra corn was described by Plurad (1934) and Capinpin (1937) as having a lighter color, more plump ears, larger cob, and softer texture than the College strain (fig. 1). In the field, these strains exhibit differences in stand and in the color and size of the leaves. The College and the Pangasinan strains appear to have the same size and color of leaves. The Pangasinan strain is slightly taller than the College strain. The Nueva Vizcaya strain has a tall and slender stalk, with rough, dark, narrow leaves. The Abra strain has a short, stocky stalk, with rough, dark, broad leaves.

Preparation of the breeding plots. A piece of land 36 meters by 100 was first plowed by a Fordson Tractor and then twice by a native plow, and harrowed after each plowing. After the land had been thoroughly prepared, six rectangular plots (8 meters by 48 meters), with an area of 384 square meters each, were laid out four meters apart. Each plot was furrowed lengthwise. Each plot had eight long furrows one meter apart. The space of four meters between plots was also furrowed. As these furrows were one meter apart, there were four between two plots. These were planted to broom corn sorghum eight days before the corn, to serve as barriers against pollen grains from other plots.

Wet-season hybridization planting. All the strains, except the Abra, were planted on June 13, 1936. Plurad (1934) found that the Abra strain tasseled 38 days after planting and silked 4 days later in the wet-season culture. The Los Baños strain, on the other hand, produced tassels 46 days after planting, and the silk was observed to appear 51 days after planting. This shows that the difference in age of tasseling and silking of the two strains was 9 days. In these experiments, the Abra strain was planted on June 20, 1936, or 7 days after the other three strains were planted at the same time, in order that tasseling and silking would more or less coincide with the latter three strains in all the breeding plots.

Position of strains in the plots. Two strains were planted alternately in each plot, one row to be detasseled and the other to remain undetasseled. They were so distributed in plots that at harvest first generation seed strain combinations as well as parental seeds could be obtained.

Methods of detasseling. The stalks were detasseled as soon as they had partially emerged from the plant. No artificial pollination was done. Only wind was considered responsible for the pollination of the ears of the detasseled plants. Detasseling was done every day for two weeks between 5:00 o'clock and 7:00 o'clock in the afternoon and very early in the morning between 5:00 o'clock and 6:00 o'clock. The number of plants detasseled at a time and the time spent in the operation for every plot were recorded.

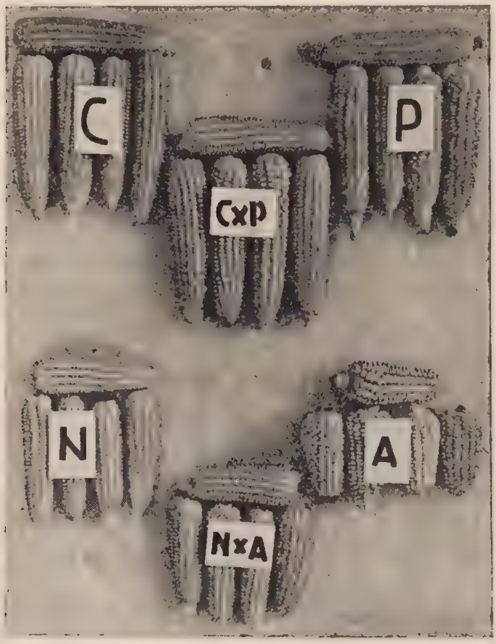

Fig. 2a.—Showing the combinations studied: (C) College strain, (P) Pangasinan strain, (N) Nueva Vizcaya strain, and (A) Abra strain

Harvesting. Both treated and untreated plants of Abra strain were harvested on September 22, 1936, 94 days after being planted; the Nueva Vizcaya strain, September 24, 1936, or 103 days after being planted; the College strain, October 2 to 4, 1936, or 109 to 111 days after being planted; and the Pangasinan strain, September

28, 1936, or 105 days after being planted. The treated plants in each plot were harvested first, and the ears were placed in sacks properly labeled for each treatment. Harvesting was done by snapping the ears from the stalk, after which they were brought to the plant breeding laboratory and partially husked. The remaining bracts served as hangers for drying in the laboratory.

Selecting seeds for the comparative planting. The volume of good kernels obtained from the untreated strains was not determined. Only three gantas of shelled grains from each undetasseled strain were reserved for the subsequent comparative planting. The harvest from each treated strain, after being thoroughly dried, was hand-shelled separately. The kernels of each strain and hybrid were placed in cloth bags labelled to correspond with the contents and were kept in air-tight containers.

Dry-season hybridization planting. The dry-season planting was performed in the same lots as the first hybridization planting (wet-season planting). The planting material was taken from the untreated plants of the different regional strains harvested in the previous season.

Comparative cultures

In this study, only two comparative plantings were originally called for, the dry and the wet season plantings, but actually three comparative plantings, two dry-seasons and one wet-season, were made.

Dry-season planting of F_1 seeds. For the first dry-season planting, to be known hereafter as dry-season original planting, 50 lots measuring 14 meters by 25, containing 350 square meters each, or a total area of 17,500 square meters, were used. There were 5 replications made for each parent strain and F_1 hybrid. A total of 11.78 gantas of seeds were planted. The seeds used were taken from the wet-season hybridization planting. Because of the typhoon and heavy rains which occurred on Nov. 7, Dec. 2, and Dec. 3, 1936, several lots were destroyed. Out of 50 lots, 30 had not been greatly affected, and these were the only ones considered.

Dry-season duplicate planting of F_1 seed. In this duplicate dry-season culture, 50 lots, measuring 10 meters by 20 meters, or 200 square meters each, or a total area of 10,000 square meters, were used. This field had been planted to corn formerly. The seeds were planted on December 14, 1936. A total of 5.11 gantas of seeds left in the first dry-season planting was used. The production of more

F_1 seeds was therefore necessary for the wet-season comparative planting.

Wet-season planting of F_1 seed. For the wet-season planting, 50 lots, 10 meters by 20, or 200 square meters each, or a total area of 10,000 square meters, were used. The land is fairly level and very fertile. It was prepared as usual. About 5.33 gantas of seed were planted.

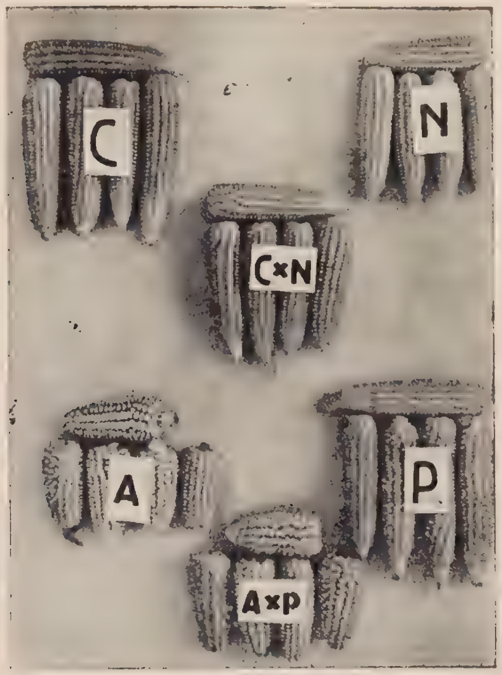

Fig. 2b.—Showing the combinations studied

Field study of each strain and hybrid in both dry- and wet-season plantings

Measurement of height. A fairly reliable index of growth vigor is the average height of plants. One hundred plants from each combination and parent strain were selected at random from all the lots before the ears were fully mature. When the ears were mature, these plants were measured with a calibrated meter stick from the surface of the ground up to the blade joint of the flag leaf of the plant. The same procedure was followed in all the season plantings.

Measurement of ear length. The length of the ear was measured from those plants which had been measured for height. Soon after the ear had been harvested, it was measured by a ruler. Ears that were not immediately measured in the field were marked with their husk on and brought to a convenient place to be measured later. Measurements were taken from the base of the cob up to the filled portion at the tip.

RESULTS AND DISCUSSION

The results of these investigations are given in tables 1 to 5.

Height of parent strains and F_1 hybrids

Tables 1, 1a, and 1b show that the first generation crosses, with two exceptions (table 1b), exceeded in height of plants either one of the parents or both. This increase in height of the F_1 crosses was manifested in either one or both seasons of plantings. The combination which was taller than one of the parents in both dry-season plantings was (Abra × College) F_1 hybrid, and the hybrids which exceeded one of the parents in all plantings were: (Abra × Pangasinan) F_1 and (Nueva Vizcaya × Abra) F_1 hybrids. Those which exceeded both parents in height in either one or two plantings were: (College × Pangasinan) F_1, (Pangasinan × Nueva Vizcaya) F_1, and (College × Nueva Vizcaya) F_1 hybrids. Two of the hybrids, (College × Pangasinan) F_1 and (Pangasinan × Nueva Vizcaya) F_1 hybrids, however, gave shorter plants than either one of the parents in the wet-season culture. The uniformity in height was clearly shown by all first generation crosses, in which the coefficient of variation was in general lower than that of either one or both of the parental varieties.

Length of ears of parent strains and F_1 hybrids

It will be noted in tables 2, 2a, and 2b that there was an increase in length of ear as the result, probably, of heterosis. The different combinations showed a gain in length over either one parent or both parents. The F_1 hybrids which gave significantly longer ears than one of the parents in two plantings were: (Abra × College) F_1 and (Abra × Pangasinan) F_1 hybrids. The (Abra × College) F_1 hybrid, however, gave shorter ears than either of the parents in one planting (see table 2b). Those which exceeded both parents in one planting were: (College × Nueva Vizcaya) F_1, (Pangasinan × Nueva Vizcaya) F_1, and (Nueva Vizcaya × Abra) F_1 hybrids, while the combination which gave longer ears than both parents in both dry-season plantings was (College × Pangasinan) F_1 hybrid.

In length of ear, the coefficient of variation was in general less in the first generation hybrids than in both or one of the parental strains. One combination, (College × Nueva Vizcaya) F_1 hybrid, was, however, more variable than either of the parents in one out of three plantings.

Comparative yields of F_1 hybrids and parent strains

In tables 3, 3a, and 3b, it will be noted that (Abra × College) F_1 and (Abra × Pangasinan) F_1 hybrids gave significantly higher yield of ears than one of their corresponding parents in one planting, and (Nueva Vizcaya × Abra) F_1 hybrid, in two plantings. The F_1 cross which exceeded one of the parents in all plantings was (College × Nueva Vizcaya) F_1 hybrid, while those combinations which exceeded both parents in yield in one planting were: (College × Pangasinan) F_1 and (Pangasinan × Nueva Vizcaya) F_1 hybrids.

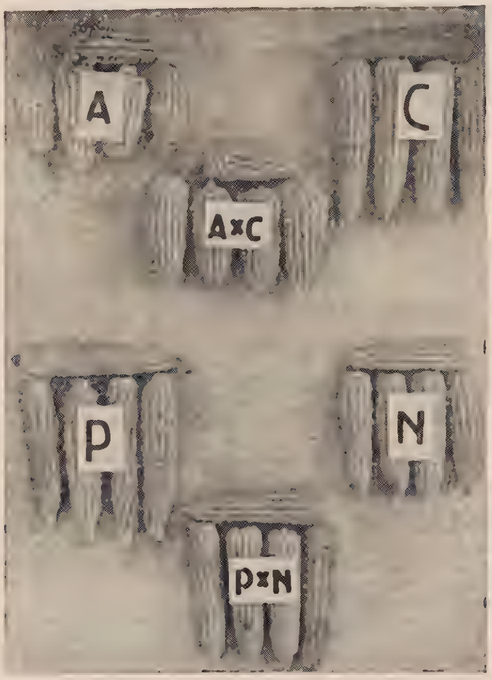

Fig. 2c.—Showing the combinations studied

In shelled corn, the hybrids also exceeded either one or both parents. The F_1 cross which gave a significantly higher yield than one of the parents in one planting was (Abra × College) F_1 hybrid, and those which exceeded one parent in two plantings were: (College × Nueva Vizcaya) F_1 and (Nueva Vizcaya × Abra) F_1 hybrids. The combinations which exceeded both parents in one planting were: (College × Pangasinan) F_1 and (Pangasinan × Nueva Vizcaya) F_1 hybrids. These results corroborate the findings of Philippine workers, Mendiola (1914) and Marquez (1917).

Yield of F_1 hybrids and parent strains

Table 4 shows that, while all of the F_1 hybrids exceeded their lower yielding parent and the average of both parents, yet only three hybrids, (College × Pangasinan) F_1, (College × Nueva Vizcaya) F_1, and (Pangasinan × Nueva Vizcaya) F_1 hybrids, exceeded the higher yielding parents.

The percentage of increase in the yield of the F_1 crosses over their lower yielding parent ranged from 19.6 to 38.3 per cent, and the increase in the yields of the F_1 hybrids over the average of both parents ranged from 3.6 to 30.6 per cent. The percentage of increase in the yield of those hybrids which yielded more than their higher yielding parents ranged from 7.9 to 25 per cent.

The foregoing data show that under existing conditions of the experiment, the utilization of first generation hybrid seed of some of these regional strains of Philippine corn studied becomes advantageous, for three out of six combinations have shown an increased yield over both of their corresponding parents. The advisability of using hybrid seed will of course depend upon whether the increase resulting from hybrid vigor more than compensates for the labor of producing this cross-bred seed.

Cost of producing F_1 hybrid seeds

It was found that in all cultures a total of 22.22 gantas of F_1 hybrid seeds were planted. These required ₱0.31 for detasseling, at the rate of ₱0.10 an hour for each laborer. To produce a ganta of seed, therefore, ₱0.02 worth of labor was necessary.

It has been stated elsewhere in this paper that no artificial pollination was done in this hybridization. Only a natural agency, the wind, was responsible for the pollination of the ears of detasseled plants. The above figures show that increased yield of corn may be obtained with F_1 seed at very low cost.

Gain or loss in the use of F_1 hybrid seeds

By reference to tables 5 and 5a, it will be noted that in all plantings there was a profit from F_1 hybrids when compared with both parents or with one parent, but a loss when compared with the other parent. The F_1 hybrids which gave a profit as compared with both parents were: (College × Pangasinan) F_1, (College × Nueva Vizcaya) F_1, (Pangasinan × Nueva Vizcaya) F_1, and (Nueva Vizcaya × Abra) F_1 hybrids (see table 5a). The combinations which gave a profit over one parent but a loss when compared with the other were: (Abra × Pangasinan) F_1 and (Abra × College) F_1 hybrids. In the case of (Abra × Pangasinan) F_1 hybrid, however, the loss sustained was more than compensated for by a profit obtained when compared with the other parent.

SUMMARY AND CONCLUSIONS

These experiments report the agronomic value of first generation crosses between geographical strains of Native Yellow Flint corn, the cost of producing first generation hybrid seed, and the results of using these F_1 seeds for increasing corn yield. The results obtained may be summarized as follows:

1. There was an increase in height of plants and ear length of the F_1 hybrids. The combinations either exceeded the shorter parent in two or three plantings, or both parents in one or two plantings.

2. Increased production of corn ear and shelled corn, presumably resulting from hybrid vigor, was realized in nearly all of the combinations. The increase of production of these F_1 hybrids over their parents ranged from 7.9 to 38.3 per cent. If both seasons are considered, the average yield per hectare of shelled corn of (College × Pangasinan) F_1 was higher than its parents; (College × Nueva Vizcaya) F_1, higher than both of its parents in all plantings; (Nueva Vizcaya × Abra) F_1 hybrid, higher than both parents in two plantings; and (Pangasinan × Nueva Vizcaya) F_1 hybrid, higher than both parents in one season and one parent in both plantings of the dry-season.

3. The additional cost of producing F_1 seed was more than compensated for by the increase in yield in the case of the following F_1 hybrids: (College × Pangasinan) F_1, (College × Nueva Vizcaya) F_1, (Pangasinan × Nueva Vizcaya) F_1, (Nueva Vizcaya × Abra) F_1, and (Abra × Pangasinan) F_1.

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TABLE 1

Variation constants on height of parent strains and F_1 hybrids of dry-season original planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	104.79 ± 0.92	13.70 ± 0.65	13.07 ± 0.64
College strain	144.13 ± 1.17	17.47 ± 0.83	12.12 ± 0.58
Pangasinan strain	124.55 ± 0.95	14.23 ± 0.67	11.42 ± 0.55
Nueva Vizcaya strain	134.77 ± 1.06	15.86 ± 0.75	11.76 ± 0.57
(Abra × College) F_1	123.73 ± 1.01	15.02 ± 0.71	12.13 ± 0.59
(Abra × Pangasinan) F_1	114.56 ± 0.90	13.40 ± 0.63	11.69 ± 0.56
(College × Pangasinan) F_1	144.47 ± 1.03	15.32 ± 0.73	10.60 ± 0.51
(College × N. Vizcaya) F_1	134.96 ± 0.94	14.03 ± 0.66	10.39 ± 0.50
(Pangasinan × N. Vizcaya) F_1	143.97 ± 1.05	15.64 ± 0.74	10.86 ± 0.52
(Nueva Vizcaya × Abra) F_1	134.67 ± 1.05	15.62 ± 0.74	11.59 ± 0.56

TABLE 1a

Variation constants on height of parent strains and F_1 hybrids of dry-season duplicate planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	124.08 ± 1.01	15.04 ± 0.71	12.12 ± 0.58
College strain	155.29 ± 1.31	19.55 ± 0.93	12.58 ± 0.61
Pangasinan strain	135.32 ± 1.16	17.22 ± 0.82	17.72 ± 0.61
Nueva Vizcaya strain	154.74 ± 1.22	18.17 ± 0.86	11.61 ± 0.56
(Abra × College) F_1	134.58 ± 0.76	11.28 ± 0.53	8.38 ± 0.40
(Abra × Pangasinan) F_1	134.41 ± 0.84	12.57 ± 0.59	9.35 ± 0.45
(College × Pangasinan) F_1	174.25 ± 0.99	14.72 ± 0.70	8.44 ± 0.40
(College × N. Vizcaya) F_1	173.42 ± 1.23	18.31 ± 0.87	10.55 ± 0.51
(Pangasinan × N. Vizcaya) F_1	154.89 ± 0.87	13.03 ± 0.62	8.41 ± 0.40
(Nueva Vizcaya × Abra) F_1	153.98 ± 0.86	12.76 ± 0.60	8.28 ± 0.39

TABLE 1b

Variation constants on height of parent strains and F_1 hybrids of wet-season planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	174.73 ± 1.21	17.99 ± 0.85	10.29 ± 0.48
College strain	234.31 ± 0.88	13.16 ± 0.62	5.61 ± 0.26
Pangasinan strain	224.61 ± 1.23	18.37 ± 0.87	8.17 ± 0.38
Nueva Vizcaya strain	234.41 ± 1.15	17.09 ± 0.81	7.29 ± 0.34
(Abra × College) F_1	175.11 ± 0.84	12.56 ± 0.59	7.17 ± 0.34
(Abra × Pangasinan) F_1	214.53 ± 0.85	12.68 ± 0.60	5.91 ± 0.28
(College × Pangasinan) F_1	204.60 ± 0.74	11.09 ± 0.52	5.42 ± 0.25
(Pangasinan × N. Vizcaya) F_1 .	215.01 ± 1.03	15.32 ± 0.73	7.12 ± 0.33
(College × N. Vizcaya) F_1	244.55 ± 1.20	17.85 ± 0.85	7.29 ± 0.34
(Nueva Vizcaya × Abra) F_1 ..	215.14 ± 1.07	15.90 ± 0.75	7.39 ± 0.35

TABLE 2

Variation constants of length of ears of parent strains and F_1 hybrids of dry-season original planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	11.22 ± 0.08	1.26 ± 0.06	11.23 ± 0.53
College strain	16.03 ± 0.10	1.56 ± 0.07	9.73 ± 0.46
Pangasinan strain	15.44 ± 0.11	1.76 ± 0.68	11.39 ± 0.62
Nueva Vizcaya strain	13.97 ± 0.08	1.26 ± 0.06	9.02 ± 0.43
(Abra × College) F_1	12.35 ± 0.08	1.23 ± 0.05	9.87 ± 0.47
(Abra × Pangasinan) F_1	11.31 ± 0.08	1.20 ± 0.05	10.61 ± 0.51
(College × Pangasinan) F_1	16.81 ± 0.09	1.47 ± 0.07	8.72 ± 0.42
(College × N. Vizcaya) F_1	15.31 ± 0.10	1.50 ± 0.07	9.81 ± 0.47
(Pangasinan × N. Vizcaya) F_1 .	15.49 ± 0.10	1.49 ± 0.07	9.61 ± 0.46
(Nueva Vizcaya × Abra) F_1 ...	14.65 ± 0.07	1.10 ± 0.05	7.50 ± 0.36

TABLE 2a

Variation constants of length of ears of parent strains and F₁ hybrids of dry-season duplicate planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	11.90 ± 0.08	1.29 ± 0.06	10.83 ± 0.52
College strain	17.05 ± 0.13	2.04 ± 0.09	11.96 ± 0.58
Pangasinan strain	16.14 ± 0.14	2.13 ± 0.10	13.19 ± 0.64
Nueva Vizcaya strain	15.76 ± 0.13	2.05 ± 0.09	13.00 ± 0.63
(Abra × College) F_1	14.38 ± 0.09	1.35 ± 0.06	9.38 ± 0.45
(Abra × Pangasinan) F_1	13.86 ± 0.10	1.59 ± 0.07	11.47 ± 0.55
(College × Pangasinan) F_1	19.30 ± 0.12	1.83 ± 0.09	9.48 ± 0.45
(College × N. Vizcaya) F_1	17.71 ± 0.09	1.39 ± 0.06	7.84 ± 0.37
(Pangasinan × N. Vizcaya) F_1	16.87 ± 0.10	1.61 ± 0.07	9.54 ± 0.45
(Nueva Vizcaya × Abra) F_1	14.40 ± 0.10	1.63 ± 0.07	11.31 ± 0.55

TABLE 2b

Variation constants of length of ears of parent strains and F₁ hybrids of wet-season planting

PARENT STRAINS AND F_1 HYBRIDS	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	cm.		*per cent*
Abra strain	14.89 ± 0.12	1.78 ± 0.08	11.94 ± 0.57
College strain	18.30 ± 0.13	2.04 ± 0.09	11.14 ± 0.53
Pangasinan strain	20.16 ± 0.12	1.89 ± 0.09	9.37 ± 0.44
Nueva Vizcaya strain	18.90 ± 0.18	2.74 ± 0.13	14.49 ± 0.70
(Abra × College) F_1	14.85 ± 0.10	1.58 ± 0.07	10.63 ± 0.51
(Abra × Pangasinan) F_1	16.36 ± 0.11	1.65 ± 0.07	10.08 ± 0.48
(College × Pangasinan) F_1	20.11 ± 0.11	1.73 ± 0.08	8.60 ± 0.41
(College × N. Vizcaya) F_1	18.64 ± 0.10	1.62 ± 0.07	8.69 ± 0.41
(Pangasinan × N. Vizcaya) F_1	19.12 ± 0.10	1.62 ± 0.07	7.92 ± 0.37
(Nueva Vizcaya × Abra) F_1	17.08 ± 0.10	1.56 ± 0.07	9.12 ± 0.43

TABLE 3

Comparative yield between F_1 hybrids and parent strains of dry-season original planting

F_1 HYBRIDS AND PARENT STRAINS COMPARED	AVERAGE YIELD PER PLOT OF EAR CORN	DIFFERENCE	AVERAGE YIELD PER PLOT OF SHELLED CORN	DIFFERENCE
	kilos	*kilos*	*kilos*	*kilos*
Abra × College F_1 hybrid	17.53 ± 2.01		14.93 ± 1.73	
Abra	12.07 ± 1.38	+ 5.46 ± 2.44	10.00 ± 1.14	+ 4.93 ± 2.07
College	18.80 ± 3.35	— 1.27 ± 3.91	15.73 ± 3.68	— 0.80 ± 4.07
Abra × Pangasinan F_1 hybrid	15.33 ± 0.97		12.57 ± 0.76	
Abra	12.07 ± 1.38	+ 3.26 ± 1.69	10.00 ± 1.14	+ 2.57 ± 1.38
Pangasinan	15.17 ± 1.07	+ 0.16 ± 1.44	12.40 ± 0.83	+ 0.17 ± 1.35
College × Pangasinan F_1 hybrid	26.40 ± 1.35		21.93 ± 1.14	
College	18.80 ± 3.35	+ 7.60 ± 3.64	15.73 ± 3.68	+ 6.20 ± 3.86
Pangasinan	15.17 ± 1.07	+11.23 ± 1.72 S	12.40 ± 0.83	+ 9.53 ± 1.41 S
College × Nueva Vizcaya F_1 hybrid	29.87 ± 1.08		24.87 ± 1.16	
College	18.80 ± 3.35	+11.07 ± 3.52 S	15.73 ± 3.68	+ 9.14 ± 3.86
Nueva Vizcaya	23.47 ± 2.53	+ 6.40 ± 2.75	19.87 ± 2.26	+ 5.00 ± 2.54
Pangasinan × Nueva Vizcaya F_1 hybrid	23.73 ± 1.82		19.80 ± 1.50	
Pangasinan	15.17 ± 1.07	+ 8.56 ± 2.11 S	12.40 ± 0.83	+ 7.40 ± 1.72 S
Nueva Vizcaya	23.47 ± 2.53	+ 0.26 ± 3.12	19.87 ± 2.26	— 0.07 ± 2.73
Nueva Vizcaya × Abra F_1 hybrid	17.93 ± 1.67		15.07 ± 1.43	
Nueva Vizcaya	23.47 ± 2.53	— 5.54 ± 3.03	19.87 ± 2.26	— 4.80 ± 2.70
Abra	12.07 ± 1.38	+ 5.86 ± 2.17	10.00 ± 1.14	+ 5.07 ± 1.83

+ Difference is in favor of hybrid.
— Difference is in favor of parent.
S Difference is statistically significant.

TABLE 3a

Comparative yield between F_1 hybrids and parent strains of dry-season duplicate planting

F_1 HYBRIDS AND PARENT STRAINS COMPARED	AVERAGE YIELD PER PLOT OF EAR CORN	DIFFERENCE	AVERAGE YIELD PER PLOT OF SHELLED CORN	DIFFERENCE
	kilos	*kilos*	*kilos*	*kilos*
Abra × College F_1 hybrid	30.07 ± 1.57		24.43 ± 1.23	
Abra	22.03 ± 0.48	+ 8.04 ± 1.64 S	17.97 ± 0.36	+ 6.46 ± 1.69 S
College	30.57 ± 1.33	— 0.50 ± 2.06	23.53 ± 1.03	+ 0.90 ± 1.60
Abra × Pangasinan F_1 hybrid	25.63 ± 1.03		21.37 ± 1.27	
Abra	22.03 ± 0.48	+ 3.60 ± 1.14 S	17.97 ± 0.36	+ 3.40 ± 1.71
Pangasinan	35.47 ± 2.84	— 9.84 ± 3.02 S	26.83 ± 1.89	— 5.46 ± 2.21
College × Pangasinan F_1 hybrid	41.20 ± 1.59		31.40 ± 1.70	
College	30.57 ± 1.33	+10.63 ± 2.08 S	23.53 ± 1.03	+ 7.87 ± 1.98 S
Pangasinan	35.47 ± 2.84	+ 5.73 ± 3.26	26.83 ± 1.80	+ 4.57 ± 2.48
College × Nueva Vizcaya F_1 hybrid	35.00 ± 1.92		27.80 ± 1.37	
College	30.57 ± 1.33	+ 4.43 ± 2.34	23.53 ± 1.03	+ 4.27 ± 1.72
Nueva Vizcaya	27.77 ± 0.61	+ 7.23 ± 2.01 S	21.80 ± 0.60	+ 6.00 ± 1.50 S
Pangasinan × Nueva Vizcaya F_1 hybrid	30.63 ± 1.44		24.13 ± 0.73	
Pangasinan	35.47 ± 2.84	— 4.84 ± 3.19	26.83 ± 1.80	— 2.70 ± 1.96
Nueva Vizcaya	27.77 ± 0.61	+ 2.86 ± 1.56	21.80 ± 0.60	+ 2.33 ± 0.99
Nueva Vizcaya × Abra F_1 hybrid	27.87 ± 0.42		22.70 ± 0.37	
Nueva Vizcaya	27.77 ± 0.61	+ 0.10 ± 0.74	21.80 ± 0.60	+ 0.90 ± 0.71
Abra	22.03 ± 0.48	+ 5.84 ± 0.64 S	17.97 ± 0.36	+ 4.73 ± 1.20 S

+ Difference is in favor of hybrid.
— Difference is in favor of parent.
S Difference is statistically significant.

TABLE 3b

Comparative yield between F_1 hybrids and parent strains of wet-season planting

F_1 HYBRIDS AND PARENT STRAINS COMPARED	AVERAGE YIELD PER PLOT OF EAR CORN	DIFFERENCE	AVERAGE YIELD PER PLOT OF SHELLED CORN	DIFFERENCE
	kilos	*kilos*	*kilos*	*kilos*
Abra × College F_1 hybrid	54.78 ± 2.30		44.70 ± 2.51	
Abra	54.38 ± 2.54	+ 0.40 ± 3.43	44.54 ± 2.30	+ 0.16 ± 3.40
College	72.56 ± 0.74	−17.78 ± 2.17 S	62.68 ± 0.95	−17.98 ± 2.68 S
Abra × Pangasinan F_1 hybrid	59.00 ± 2.79		50.28 ± 2.46	
Abra	54.38 ± 2.54	+ 4.63 ± 3.78	44.54 ± 2.30	+ 5.74 ± 3.37
Pangasinan	64.74 ± 2.52	− 5.74 ± 3.76	54.86 ± 2.09	− 4.58 ± 3.28
College × Pangasinan F_1 hybrid	75.28 ± 0.47		66.38 ± 0.39	
College	72.56 ± 0.74	+ 2.72 ± 0.88 S	62.68 ± 0.95	+ 3.70 ± 1.02 S
Pangasinan	64.74 ± 2.52	+10.54 ± 2.57 S	54.86 ± 2.09	+11.52 ± 2.12 S
College × Nueva Vizcaya F_1 hybrid	74.40 ± 0.84		64.24 ± 0.72	
College	72.56 ± 0.74	+ 1.84 ± 1.12	62.68 ± 0.95	+ 1.56 ± 1.19
Nueva Vizcaya	64.58 ± 2.32	+ 9.82 ± 2.46 S	55.76 ± 2.19	+ 8.48 ± 2.30 S
Pangasinan × Nueva Vizcaya F_1 hybrid	74.18 ± 0.91		63.54 ± 0.78	
Pangasinan	64.74 ± 2.52	+ 9.44 ± 2.69 S	54.86 ± 2.09	+ 8.68 ± 2.23 S
Nueva Vizcaya	64.58 ± 2.32	+ 9.60 ± 2.49 S	55.76 ± 2.19	+ 7.78 ± 2.32 S
Nueva Vizcaya × Abra F_1 hybrid	69.32 ± 1.59		58.52 ± 1.35	
Nueva Vizcaya	64.58 ± 2.32	+ 4.74 ± 2.81	55.76 ± 2.19	+ 2.76 ± 2.57
Abra	54.38 ± 2.54	+14.94 ± 3.00 S	44.54 ± 2.30	+13.98 ± 2.66 S

+ Difference is in favor of hybrid.
— Difference is in favor of parent.
S Difference is statistically significant.

TABLE 4

Average per cent increase or decrease in the yields of F_1 hybrids over or below the yield of parent strains per hectare in cavans of shelled corn for all season plantings

HYBRIDS AND PARENT STRAINS	HYBRID OVER (+) OR BELOW (−) LOWER YIELDING PARENT	HYBRID OVER (+) OR BELOW (−) HIGHER YIELDING PARENT	HYBRID OVER (+) OR BELOW (−) AVERAGE OF PARENT
	per cent	*per cent*	*per cent*
Abra × College	+28.4	—	—
Abra	—	−14.0	—
College	—	—	+ 4.6
Abra × Pangasinan	+19.6	—	—
Abra	—	−10.9	—
Pangasinan	—	—	+ 3.6
College × Pangasinan	+38.3	—	—
Pangasinan	—	+25.0	—
College	—	—	+30.6
College × Nueva Vizcaya	+25.1	—	—
College	—	+21.6	—
Nueva Vizcaya	—	—	+22.4
Pangasinan × Nueva Vizcaya	+21.0	—	—
Pangasinan	—	+ 7.9	—
Nueva Vizcaya	—	—	+10.7
Nueva Vizcaya × Abra	+35.0	—	—
Abra	—	− 7.0	—
Nueva Vizcaya	—	—	+10.3

TABLE 5

Gain or loss per hectare of shelled corn from the use of F_1 hybrid seeds in the dry-season

HYBRIDS AND PARENT STRAINS	COMPUTED INCREASE (+) OR DECREASE (−) IN THE YIELD OF F_1-HYBRIDS IN CAV. OF SHELLED CORN		VALUE OF INCREASE (+) OR DECREASE (−) AT ₱2.50 PER CAVAN	COMPUTED COST OF PRODUCING SEEDS FOR A HECTARE	PROFIT (+) OR LOSS (−) FROM THE USE OF F_1-HYBRID SEEDS
	Original planting	Duplicate planting			
	cavans	*cavans*	*pesos*	*pesos*	*pesos*
Abra × College					
Abra	+2.41	+5.53	+19.85	0.34	+19.51
College	−0.39	+0.77	+ 0.95	0.34	+ 0.61
Abra × Pangasinan					
Abra	+1.25	+3.41	+14.96	0.16	+14.80
Pangasinan	+0.08	−4.77	−11.73	0.16	−11.89
College × Pangasinan					
College	+3.03	+6.72	+24.38	0.04	+24.34
Pangasinan	+4.66	+3.90	+21.40	0.04	+21.36
College × Nueva Vizcaya					
College	+4.29	+3.65	+19.85	0.21	+19.64
Nueva Vizcaya	+2.27	+5.13	+18.50	0.21	+18.29
Pangasinan × Nueva Vizcaya					
Pangasinan	+3.62	−2.31	+ 3.28	0.12	+ 3.16
Nueva Vizcaya	−0.03	+1.99	+ 4.90	0.12	+ 4.78
Nueva Vizcaya × Abra					
Nueva Vizcaya	−2.35	+0.77	− 3.95	0.16	− 4.11
Abra	+2.47	+4.05	+16.30	0.16	+16.14

TABLE 5a

Gain or loss per hectare of shelled corn from the use of F_1 hybrid seeds

HYBRIDS AND PARENT STRAINS	WET-SEASON CULTURE				TOTAL PROFIT OR LOSS FOR BOTH SEASON CULTURES
	Computed increase (+) or decrease (−) in yield of F_1 hybrids	Value of increase or decrease at ₱2.50 per cavan	Cost of producing seeds for a hectare land	Profit (+) or loss (−) from the use of F_1 seeds	
	cavans	*pesos*	*pesos*	*pesos*	*pesos*
(Abra × College) F_1					
Abra	+ 0.13	+ 0.33	0.03	+ 0.30	+ 19.81
College	− 15.17	− 37.93	0.03	− 37.96	− 37.35
(Abra × Pangasinan) F_1					
Abra	+ 4.84	+ 12.10	0.03	+ 12.07	+ 26.87
Pangasinan	− 3.86	− 9.65	0.03	− 9.68	− 21.57
(College × Pangasinan) F_1					
College	+ 3.11	+ 7.78	0.04	+ 7.74	+ 32.08
Pangasinan	+ 9.71	+ 24.28	0.04	+ 24.24	+ 45.60
(College × Nueva Vizcaya) F_1					
College	+ 1.31	+ 3.28	0.04	+ 3.24	+ 22.88
Nueva Vizcaya	+ 7.15	+ 17.88	0.04	+ 17.84	+ 36.13
(Pangasinan × N. Vizcaya) F_1					
Pangasinan	+ 7.32	+ 18.30	0.04	+ 18.26	+ 21.42
Nueva Vizcaya	+ 6.56	+ 16.40	0.04	+ 16.36	+ 21.14
(Nueva Vizcaya × Abra) F_1					
Nueva Vizcaya	+ 2.33	+ 5.83	0.04	+ 5.79	+ 1.68
Abra	+ 11.79	+ 29.48	0.04	+ 29.44	+ 45.58

NOTE: OUR MANAGING EDITOR ATTENDS THE INTERNATIONAL ENTOMOLOGICAL CONGRESS AND THE INTERNATIONAL LOCUST CONFERENCE IN EUROPE [1]

Dr. Leopoldo B. Uichanco, of the Department of Entomology of the College of Agriculture, has been appointed by the President of the Commonwealth and by the President of the United States, as a delegate to represent the Philippines in the International Entomological Congress in Germany and in the International Locust Conference in Belgium, scheduled in August, 1938.

The selection of Doctor Uichanco to represent the Philippines in these two congresses is most appropriate because of his training, ability, and accomplishments. Doctor Uichanco is considered as the foremost entomologist of the Philippines. As an authority in entomology, he is well known for his contributions both in this country and abroad.

The attendance of Doctor Uichanco at the International Locust Conference in Belgium is of special interest because of his views on the origin of swarms of migratory locusts in the Philippines. Prior to the researches of Doctor Uichanco on the migratory locust, it was generally believed in the Philippines and elsewhere that the migratory locust may be found in the solitary phase throughout the Philippines all the time. When conditions become favorable for swarming, the insects in the solitary phase increase in vast numbers and form swarms. According to this idea, locust swarms may originate in any place and thence migrate to other regions in conspicuously large numbers destroying graminicolous crops along their path. The studies conducted by Doctor Uichanco for a number of years, taking him on two occasions to Mindanao, have changed our ideas about the breeding places of the migratory locust in the Philippines. According to the results of Doctor Uichanco's work, migratory locusts in the Philippines form swarms only in the grass lands in a limited portion of Mindanao and in nearby islands, and the solitary phase that may be found outside of these permanent breeding areas does not give rise to swarms. The appearance of swarms in the other islands of the archipelago is a result of the migration to these places of the swarms that formed in Mindanao or its immediate neighborhood. After migration to the other islands, the swarms may be greatly reduced in numbers owing to unfavorable conditions and various other factors. Finally, the swarms are reduced to the solitary phase and remain in this condition until they finally die out. In the event Doctor Uichanco's conclusions are accepted, locust specialists of the old school may find it necessary to revise their views regarding the outbreak of swarms of this important agricultural pest.

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[1] General contribution No. 619.

G. O. OCFEMIA
Of the Department of Plant Pathology

COLLEGE AND ALUMNI NOTES

Dr. G. K. Strode and Dr. J. B. Grant, representatives of the Rockefeller foundation in Europe and in the Far East, respectively, were speakers at a convocation held in the College Auditorium on August 9.

President Manuel L. Quezon of the Philippines made a surprise visit to the College of Agriculture on August 10. Dean Gonzalez was on hand to show the chief executive around the departments.

United States High Commissioner Paul Vorries McNutt and party were all-day guests of the Los Baños Colleges on August 17. After inspecting the guard of honor, the party made the rounds of the different departments of the College of Agriculture. A convocation was held at Baker Memorial Hall where Dean Gonzalez gave a brief history of agricultural education in the Philippines before the formal introduction of the guest speaker.

The afternoon was devoted to inspection of the School of Forestry and a review of the cadet corps. The party include Mrs. McNutt and daughter, Mr. Wayne Coy, Mr. Evett D. Hester, former head of the Department of Agricultural Economics of the College, and Mr. Richard Ely.

An official invitation to the Sixth Congress of the International Society of Sugar cane Technologists to be held at Baton Rouge, Louisiana, October 24 to November 5, 1938, was received by Dr. G. O. Ocfemia on August 8.

Mr. Amando M. Dalisay of the Department of Agricultural Economics and Mr. Getulio Viado of the Department of Entomology, sailed on August 15 for the United States as fellows of the University to take advanced courses at Harvard University and Cornell University, respectively.

The new faculty additions to the College are: Mr. Bautista B. Cadiz, Instructor in Sugar Engineering, and Mr. Benjamin Labayen, Assistant Instructor in Agricultural Engineering.

UNITED STATES HIGH COMMISSIONER McNUTT VISITS THE COLLEGE OF AGRICULTURE

WITH TWO PLATES

On August 17, 1938, United States High Commissioner Paul V. McNutt honored the College of Agriculture with his first official visit. He was accompanied by Mrs. McNutt, Miss Louise McNutt, Lieutenant-Commander J. P. Rockwell, Mr. Evett D. Hester, Mr. Wayne Coy, and other members of his staff. The visitors were met at the gate by President Jorge Bocobo, Dean and Mrs. B. M. Gonzalez, Dean and Director of Forestry Florencio Tamesis, Professor and Mrs. Harold Cuzner, of the School of Forestry, and a committee of faculty members.

After reviewing his guard of honor, Commissioner McNutt and the members of his party were accompanied by the welcoming committee to the different departments of the College to see the students at work in the laboratory and in the field. From their visit to the Departments the guests were taken to Baker Memorial Hall where the High Commissioner was the principal speaker at a special convocation (Pl. 1 and 2).

Following the convocation was an official luncheon for the visitors given at Molawin Hall. After luncheon the party visited the School of Forestry and the National Botanic Gardens. Before returning to Manila the High Commissioner reviewed the Los Baños Unit of the University of the Philippines R.O.T.C.

At the special convocation in Baker Memorial Hall the High Commissioner delivered the following address:

"DEAN GONZALEZ, MEMBERS OF THE FACULTY, AND STUDENTS OF LOS BAÑOS:

I need not tell you how delightful it has been to visit your campus, your laboratories, and your fields. From the day I arrived in the Philippines, the Los Baños College of Agriculture has been talked-up to me until I began to wonder if it could be half as good as its champions represented it to be. I have not been disappointed. You have a splendid plant in a magnificent setting. Your laboratories are well equipped. Your faculty is well prepared for its task. Your student body is not too large for personal instruction. In short, your house is well kept. Altogether I deem you fortunate.

Educational institutions have played a very sizeable part in my life. The administration of colleges and universities has always attracted me and a considerable number of my years have been devoted to university work. I think I know many of the questions and a few of the answers. Perhaps if instead of law, I had gone into agriculture or science, I would know more of the answers. Be that as it may, I am sure of one thing: Progress in a modern industrial and democratic age is utterly dependent upon educated leadership. Government itself must be run by the brain, not by any other part of the anatomy.

The fostering of high standard university education is an essential duty of Government. It is not that Government should give it as a largess to its citizens. Rather, Government must provide the university for its own self-protection. Today more than in any time in the long history of man, "Science is Life".

Coming nearer at hand, every characteristic of the present day Philippine situation points to the need of scientific advancement in agriculture. Over ninety per cent of the wealth of the Islands comes from the soil and nearly all urban industry in the Philippines is merely a matter of servicing agriculture. Except in one crop—sugar—the technique of your agriculture is primitive and, at least from a standpoint of man-hours, costly.

In addition much of your export agriculture depends for its existence on such political artificialities as tariffs and trade preferences. And worse yet, the control of these tariffs and preferences is not in your hands. Do what you may, under imaginable circumstances, they may be withdrawn in a day.

There are then as I see it two fundamental problems facing Philippine Agriculture: first, production at lower unit cost; second, adaptation to withstand withdrawal of artificial factors.

To solve these problems will require more than laws and administration. Their solutions begin in the laboratory and herbarium. They demand results which can not be based on anything but seasoned application of pure natural science.

It is in this field that you of Los Baños have elected to spend your talent and enterprise. You deserve the almost lavish support of your country and its exchequer—particularly in the matter of research. I trust you will get it.

You were fortunate in having as a founder Dean Copeland whose pragmatic philosophy and doctrine of work built your foundations. You were again fortunate in receiving the impress of Dean Baker who died in your service and who is reported to have been the greatest American educator to come to these shores. His homely interpretations of science and life were spoken on this campus and no doubt influenced the minds and hearts of your faculty who were his students. You are fortunate in your third Dean who, fully trained in science, rooted to your soil and race, has given and is giving every ounce of his genius for organization and administration to your advantage.

But beyond campus and laboratories and deans I am told there is something else here. Something which no man can claim as his special contribution. Something that is a mystical outgrowth of time, place and persons of all sorts. Something you call the "Los Baños Spirit".

Those who speak of it are at a loss to define it—they say it means more than "one for all and all for one". That it requires unflinching devotion to the task in hand whether it be a student's problem, an athletic game, a senior's thesis, or a professor's research. Whether it be running a coöperative store or managing an animal husbandry project.

It is said that it means more than devotion, that it means science—the acceptance that progress both in science and life is a continuous chain of assumptions, tests of assumptions, correction and re-correction, until an item of truth stands clear and alone.

And then they say "Los Baños Spirit" means more than devotion and science: That it covers loyalty. I have been told of that memorable occasion, when, during the World War, the President of the United States and the Governor-General having called for volunteers for the Philippine National Guard, the College of Agriculture to the last student and instructor boarded a special train at Los Baños and presented themselves in Manila for whatever duty their country cared to assign them. Such mass loyalty—so great a number of Cicinnatii must have startled our urban friends.

I am told that it adds to devotion, science, and loyalty the virtue of humility. That dress and money and station are not regarded as essentials here. That something of the spirit of the scholarly friar in his cell pervades. That each man is humble in the presence of his fellowman. Jestingly, perhaps, it has been said that "Los Baños makes few mistakes but admits them all."

So then, we add them all together and we begin to appreciate that "Los Baños Spirit" is something tangible. May you never lose it. Here, under the shadow of a mountain which in itself holds all the mystery of life, amid trees that an aesthetic God designed, may you cherish and increase the "Spirit of Los Baños."

EXPLANATION OF PLATES

PLATE 1

A view of the stage at Baker Memorial Hall during the first official visit to the College of Agriculture at Los Baños of United States High Commissioner Paul V. McNutt. This picture was taken after the visit to the different departments of the College to see students at work in the laboratory and the field. Those in the picture are (from left to right): Dr. Miguel Manresa, Mr. Florencio Tamesis, Director of Forestry and Dean of the School of Forestry, United States High Commissioner McNutt, Dean B. M. Gonzalez of the College of Agriculture, President Jorge Bocobo, Lieutenant-Commander J. P. Rockwell, and Professor Harold Cuzner, in Charge of the School of Forestry.

PLATE 2

A view of a portion of the audience at the special convocation at Baker Memorial Hall. The picture was taken when the United States High Commissioner was delivering his address.

United States High Commissioner McNutt

Courtesy of *Dean of School of Forestry*

PLATE 1

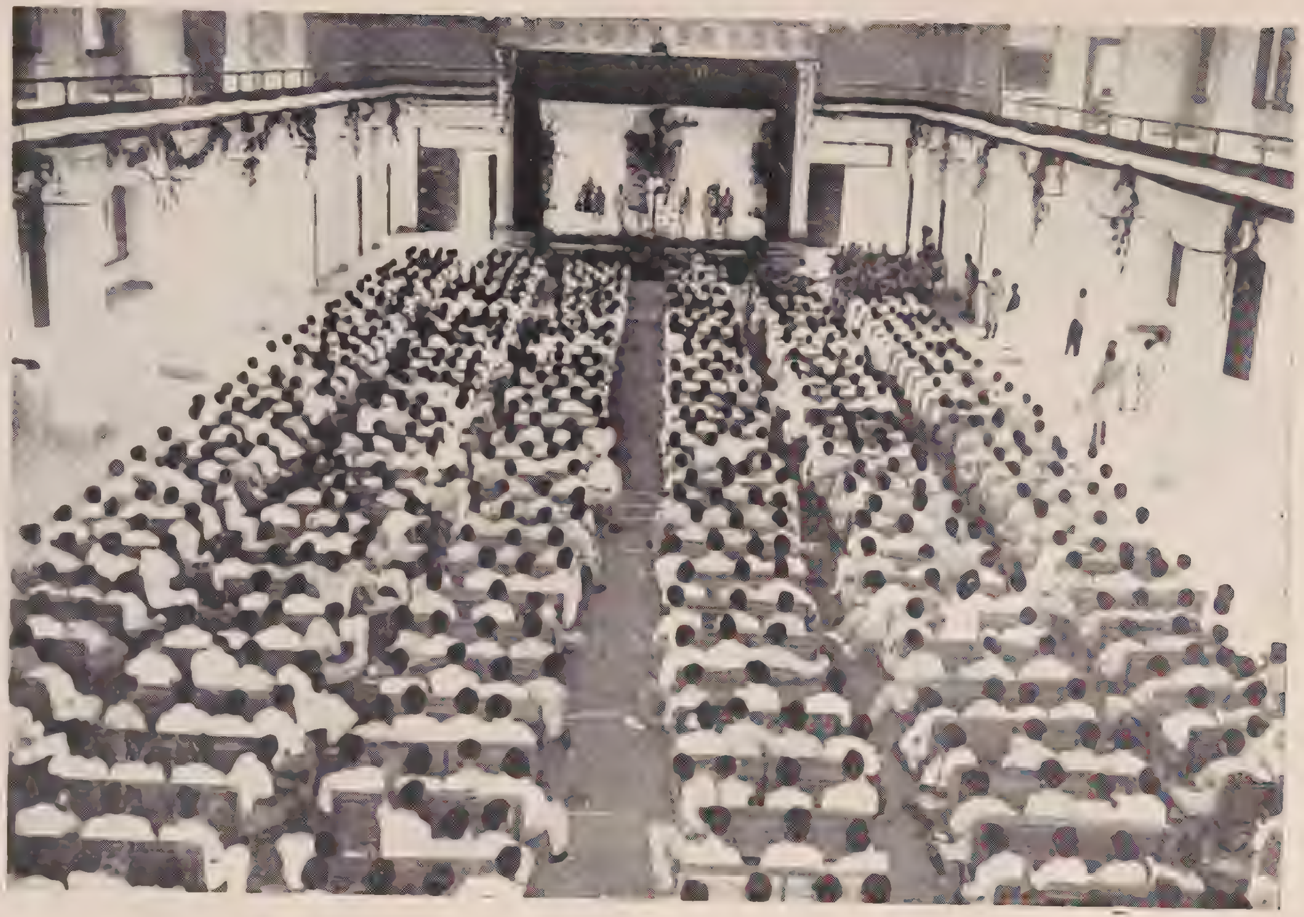

PLATE 2

Courtesy of Dean of School of Forestry

ACHIEVEMENTS IN HORTICULTURAL RESEARCH IN JAPAN[1]

TYÔZABURÔ TANAKA[2]
Of the Taihoku Imperial University

Japan produces 450,000,000 yen worth of horticultural crops, including fruits, vegetables, flowers, nursery plants, and seeds. About 425,000,000 yen worth of products are consumed in the country, 24,000,000 yen worth are exported raw, and 1,000,000 yen worth are canned, and exported as merchandise worth 4,400,000 yen. In comparison with the tremendous amount of staple food products of Japan, this figure is not large, being only 14 per cent or less, but it is about 16 per cent of the total agricultural export exclusive of silk. Fruit production amounts to nearly 350,000,000 yen. Vegetables amount to 90,000,000 yen. The output of the mainland is primarily semitropic: citrus fruit, 35 per cent; kaki, 16.3 per cent; pear, 14.2 per cent; grape, peach, and loquat, 16.3 per cent altogether; and apple and cherry the remaining 13.1 per cent. In Korea, apple is the leading crop, being 70 per cent; pear, 23 per cent; and grape, 7 per cent. In Formosa, banana takes the lead, covering 48.4 per cent; next, pineapple, 22.1 per cent; citrus fruit, 15.2 per cent; and the rest, i.e., longan, mango, areca nut, guava, plum, peach, kaki, papaya, *Eugenia malaccensis*, grape, and loquat the remaining 14.4 per cent. The remaining 8,000,000 yen is received from canned fruit and vegetables, and 2,000,000 yen from nursery plants and seeds.

The general tendency of our horticultural research is mostly toward the improvement of races. Before the activity of the Imperial Horticultural Experiment Station at Okitsu started, farmers chose their own varieties to raise, but owing to the inferiority of these varieties, a great many were not regarded as commercially important. Standardization of varieties to increase production, was planned out by Professor T. Onda, the first director of that station. The varieties introduced by the station are many, and a few examples will show how they have contributed to our horticultural production.

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[1] Paper read before Los Baños Biological Club, January 27, 1938. Miscellaneous contribution No. 21.

[2] Visiting Professor of Pomology in the College of Agriculture during the second semester of the academic year 1937-1938.

Species	*Varieties introduced*	*Present acreage (per cent of the total area)*
Pear	Nijisseiki and Chójuró	54.2
Grape	Delaware & Campbell's Early	55.7
Peach	Hakutó, Rikaku & Tenshin	28.8
Kaki	Fuyu	43.7
Chestnut	Gin'yose & Toyotama	33.2
Citrus	Satsuma (Unshiu) & Washington Navel	78.1
Apple	Ralls and Jonathan	75.8
Pumpkin	Kurokawa	26.2
Tomato	Best of all, Ponderosa and Earliana	54.9
Onion	Yellow Damvers	78.4

There are many other examples which are omitted here. Professor Kikuchi of Kyoto Imperial University introduced two new varieties of Japanese pears, which he had originated by artificial crosses: the *Yakumo* and *Kikusui*, occupying nearly 500 hectares in commercial cultivation. The *Wase Unshiu* was first introduced by the author, and it now covers a producing area of 1,240 hectares, and a non-producing area of over 2,000 hectares.

The *Wase* variety of the *Unshiu* (*Satsuma*), *Citrus unshiu* Marc. var. *Praecox* is known to produce a large thin-skinned fruit, maturing one month earlier and having greater productiveness than other varieties. Early maturity means that the fruit losses acidity very much earlier, becoming ready to eat, while other varieties remain too acid to eat. This variety was locally known in the prefecture of Oita as an interesting occurrence, but its commercial value was not detected until villagers of inland regions took interest in it. The author first ran across it in 1910, and reported it to Director Onda of the Imperial Horticultural Experiment Station, recommending that it be tried out in his station. The name, "Wase Unshiu", meaning early maturing Satsuma, was fixed by the author and a botanical name, "Forma praecox", given in the *Botanical Magazine* of Tokyo in 1912. There were several unusual things about the first trial plantings of the Wase Unshiu. Certain Wase plants propagated from the known parentage did not come true to type. A large scale investigation of individual trees was conducted. This brought out the interesting fact that some of the trees of bearing age often send forth single branches of entirely different character. In one orchard, 10 per cent of the trees were sending forth such branches and in another case the percentage was as high as 31 per cent. Later on, the branch representing something else than Wase was proved to be identical with the ordinary late maturing Owari, or most commonly planted type of Unshiu. It was also found that the variation branch is not necessarily limited to a single branch per tree, but sometimes two or even three arise from a single plant. This is of course a case of undesirable bud mutation.

Among the original trees from which the buds were taken for commercial plantings, there were three plants, but all were straight Wase plants grafted on trifoliate stock. Another tree in the neighboring village, older than these three, was found never to have supplied bud woods; the fruit character was a little different although it was essentially the Wase in nature. Since there were two Wase strains in existence, a search in the neighboring villages was made for others and finally a fine example of bud mutation originating Wase character from the ordinary Owari Satsuma was found. This was an Owari tree of about thirty years of age. A single branch growing horizontally from the lower part of the tree was found to bear very beautiful Wase fruits. The character of the fruit and branches was thoroughly examined by statistical method. It was found to be the good Wase variety, but belonging to a different strain; it was later given the name *Higuchi Wase,* after the owner of the plant. This was later found to be a very suitable strain for hot climates, but morphologically it is a flat-shaped strain while others mentioned before are rather globose-shaped. In the investigation in other prefectures, many other independent bud-mutants having the Wase characters were discovered. They are all separately named and described in papers by the author. They have proved to be independent strains, behaving in different ways in different localities and climates. The Suzuki Wase, the best strain out of fifteen mutants found in Central Japan is still the best, as later trials by the Imperial Horticultural Experiment Station and Local Prefectural Experiment Station have proved. The Miyagawa Wase was found in Kyushu to be a strain very resistant to insufficient care, and remains the best suitable strain for large scale plantings. The Matsuki Wase, producing gigantic fruits which weigh, on an average, 280 grams, is still holding its character very well under different conditions.

Many governmental institutions became interested in the segregation work conducted by the author upon independent strains of Wase Unshiu of bud mutation origin, and some employed specialists to discover other mutations and find out better varieties suitable to the different conditions. Even particularly cold regions producing poor fruits were made productive by planting new strains. Such a cold country as Osaka produced excellent fruit which won the prize in the national fruit contest held in the winter of 1936. This prize winning fruit was based upon a new strain called *Kamei Wase,* which was discovered by the director of the local citrus experiment station. The Ministry of Agriculture medal was awarded to another new strain, *Uchishiba Wase.* In the same year, Shidzuoka prefecture sponsored an exhibition and contest of Wase strains. The exhibition brought out another variety entirely different from the previously known Wase strains (nearly fifty in all). This variety produced extremely early maturing and excellent looking fruits. The discovery of such things is of great economic value. We produce 20,000,000 yen worth of fruits of Unshiu every year and we export 3,000,000 yen worth of raw fruit, besides another 3,000,000 yen worth of canned fruit. The United States consumes this raw fruit of Unshiu because it reaches the country before California fruits appear on the market. Our early maturing Unshiu fruit can easily reach America by Christmas, but the time will come when the earliest strain will reach Vancouver before Thanksgiving, if the new strain from Shidzuoka is planted on a commercial scale.

The scientific problem of the unstability, of Wase strains, their not breeding true to type by vegetative propagation, needs to be explained. Wase strains are the bud mutants of other strains, like Owari, so that coming back from Wase to Owari or to any other strain must be a case of *vegetative reversion.* No progeny test is possible because the Unshiu is a seedless variety with a very high pollen sterility; and whenever seeds are formed, it is impossible to know whether they are really sexual seeds or not because vegetative (apogamic) seed formation is very common among citrus fruits. For these reasons, the causes of such reversible mutation cannot be positively determined. It might be explained through factor mutation, or better, through "allelomorphic transformation", and also through somatic segregation of the characters of chimeric origin. The difficulty is that the change is very complicated in the case of Wase. Many simultaneous changes of character are being introduced, such as, the shape and size of fruit, thickness of the rind, size and shape of the oil cells, number and size of pulp vesicles, number of buds in the axils, and shape and size of leaves. The possibility of chromosomal mutation was also looked into, but the result was negative. The mutation is reversible, that is, the numerous characters which changed simultaneously may come back to the original characters at a single reversion. It cannot be explained by simultaneous factor mutations, or by anything subject to the change lying within the "genom". It may be "plasmogenic mutation" subject to plasmon, and not the genom, as was well explained by F. von Wettstein and supported by Professor Baur. This is a nature of change perhaps induced by certain external factors, like a strong stimulus, as a wound or a break, or unusual accumulation of nutritive substances by girdling or twisting. In many cases the mutating branches have distinct signs of disturbance very close to the point from which the mutation started. The author thought that these facts support the results of the famous but much disputed experiments of Blaringhem, showing that mutation of early maturing corn, *Zea mays*, can be introduced by traumation or decapitation of the ear and he so expressed it in a statement in 1925 which unfortunately an editor did not publish, otherwise he would have been ahead of Professor N. B. Mendiola[3] of the College of Agriculture, University of the Philippines in the support of the Blaringhem theory.

Hatton of East Malling Research Station, England, has worked upon the mutual relationship of rootstock and scion, proving that the rootstock plays a very important part in the habit of the top and the crop it bears. In the case of the apple, the top (scion) behaves very differently on various types of rootstocks which were segregated from French Dwarf seedlings. Size of the tree, number of flower buds, time of opening of the buds, amount of the crop, size and quality of fruit, and so on, are subject to variation in different rootstocks. Hatton, however, introduced no definite theory as to why the rootstock causes such a remarkable change in the scion, but Swarbrick and Roberts of Long Ashton Research Station, England, hold that such an influence is reciprocal in nature and that the scion also influences the root.

Priestly of Leeds University in a lecture to which the author was invited expressed the belief that the root supplies only water and mineral substances to the top, while the top supplies the root with formative substances like carbohydrates or amino acids; hence, there is a bigger chance of the scion having a morphological influence upon the root than the root upon the scion. Experimental data presented by Swarbrick and Roberts were, however, not sufficient to prove this. Hatton's experiments also did not show any definite qualitative difference introduced by scions upon the root system. This became a very attractive problem in pomology, and a great deal of discussions on the subject were exchanged in the Fourth International Horticultural Congress held in London in 1930. To the pomologists of Japan, however, it is a very well known fact that common rootstock of citrus, the trifoliate orange, *Poncirus trifoliata,* is a mere shrub when it is grown by itself. When it is used as rootstock, it swells up very greatly, always becoming thicker than the scion whenever the scion assumes an enormous size. This is undoubtedly the scion influence upon the root, as a citrus top is always a tree in nature, but the trifoliate stock will overgrow it when it has the citrus top; otherwise it will remain a shrub.

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[3] MENDIOLA, N. B. 1932–1933. A method of plant improvement based on the use of hidden heritable bud variations and those produced through injury. Proceedings of the Society for the Advancement of Research 1932-1933: 15–58. *Fig. 1–8.*

Mr. Yuichiro Tanaka carried out an experiment at Okitsu, using many citrus varieties as the scion and the trifoliate as the rootstock. The most remarkable result obtained was the change of the shape of root system, which showed a different amount of growth, exactly in accordance with the size of the scion species. Having the scions of sweet orange, for instance, the trifoliate stock always becomes deep rooted, or the angle of lateral root becomes very small, so that the side roots can grow very deep into the soil. Lemon top, on the other hand, has an opposite influence upon the trifoliate root, always giving a broad angle to the side root so as to give it a shallow rooting tendency; it even gives lighter color to the root. The same behavior of the lemon top to the sour orange root was reported by Dr. Halma of the University of California. It was found later that such scion influence can be seen in the Japanese persimmon, *Diospyros Kaki,* and in other fruit trees. In the case of kaki, the Saijô variety always gives a narrow angle, or deep rooting habit, to the rootstock while Yokono and Egosho varieties give a broad angle, or shallow rooting habit, to similar rootstock plants. Dr. Halma reported that the Famuse apple gives a deep rooting habit to the rootstock, whereas Akin apple gives a shallow rooting habit to the same kind of rootstock. An interesting thing also found is the rôle of intermediate rootstock upon both the scion and initial rootstock indicating the importance of the wider application of intermediate stocks in fruit culture. In the near future the use of the intermediate stock may bring about the possibility of introducing new kinds of fruit trees, which so far have been considered very difficult if not impossible under extremely different conditions. The grapefruit or Kaopan Siamese pummelo, for instance, is generally considered impossible to raise in rather cold Japanese territories, but the author succeeded in growing it in Fukuoka, by using the Unshiu, an intermediate rootstock upon initial trifoliate root. In the same way, it will be possible to raise some citrus fruits, like the very expensive Kaopan pummelo, which heretofore have not been grown outside of Nakorn Chasri region of Siam, provided some suitable intermediate rootstock is introduced.

The local horticultural officers have conducted very valuable experimental work which has greatly benefited the local fruit industry. A. D. Shamel of the United States Department of Agriculture has introduced an excellent idea of bud selection in citrus fruit. He advocates discarding all unproductive or undesirable individuals of the fruit in all orchards in California by top-working them or replanting them with better clons selected by means of individuals performance record. Such clons must be uniform bearers of good character and having a heavy yield of fruit of good quality. Such clons or individuals are multiplied through vegetative propagation, and citrus growers are required to plant only selected trees. There will be hundreds of thousands of such selected clons the budwoods of which are sold at and distributed by the Supply Company of California Fruit Growers' Exchange. Mr. Shamel is contented with this but we are not contented with having only a reliable individual in other orchards. We believe that all growers in a given locality should have in their possession the very best clon that we can find, not simply a fair individual. Each locality must have a single clon of as perfect a nature as can be obtained.

How is it possible to supply thousands of trees of single clonal line which can be trusted to be the best? One of our field men, Yasuo Okada, a horticulturist of the Citrus Experiment Station of Kagoshima prefecture, has done this. His task was to find out the most productive Unshiu plant having an excellent fruit of big size and good eating quality. He was wise enough not to start with a large number of plants. He first picked out the best orchard in his prefecture, and again selected a small number, about fifty, of the best individuals found within that orchard. He worked on these trees for about six years conducting very close observations. He carefully noted individual performances of these plants, always checking the result with other plants existing in the same orchard and in other trees of neighboring orchards. He was not contented with the result until one of his trees showed an enormous crop, averaging around six hundred and forty-six fruits during six years. These trees started bearing very young (about fifteen years). Another tree had six hundred and fourteen fruits, and three others followed closely. These five clons excelled all other individuals in the orchard, as well as all other clons from different localities in which similar bud-selection work had been carried on and from which selected clons had been sent to this station. The best two were called Kagoshima No. 6 and No. 23, and these were multiplied in enormous quantities (around 200,000 plants a year) by being raised in paddy fields, which were prepared by deep plowing. Vigorous plants were obtained by keeping absolute control of leaf miner by application of nicotine sulfate solution every three or four days. Kagoshima prefecture now has 2,300 ha. of the Unshiu, producing 700,000 yen worth of fruit, but the goal is to plant 3,500 ha. by 1942, with an approximate production of 10 million yen worth of fruit.

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A STUDY OF FOUR SYSTEMS OF MANAGING CALVES TO CONTROL INTERNAL PARASITES[1]

DENNIS M. MOLINTAS

In the production of farm animals, the proper care and management of the young stock demand a judicious consideration of all the necessary conditions that will best promote rapid growth and uninterrupted development. Careful breeding, good feeding and proper management, and the maintenance of normal physical health, as distinct but related phases in animal production, all require the proportionate attention of the stockman. The health aspect involves the prevention, control, and treatment of diseases, parasites and parasitic diseases of live stock. In nature, among the mammals the helpless young rely upon their progenitors for sustenance and for protection against visible predatory enemies. Both young and mature animals, however, greatly suffer from various diseases and parasites. It is commonly known that young animals are especially subject and susceptible to various internal parasites, which in most cases result in retarded growth, unthriftiness, and general anemia, and sometimes death.

The considerable losses from internal parasitism among ox and carabao calves in the Philippines seem to indicate that the problem of internal parasitism and its concomitant consequences have failed to receive adequate attention in the care and management of farm animals. To raise successfully the calves to maturity, economically and profitably, requires some special care and attention with regard to protecting them in their most susceptible period from internal parasites. This problem of parasite control is most important in the Islands where the open and unfenced common pastures are both the feeding grounds of ill-managed range animals and the breeding habitations of persistent parasites, like the different species of Ascaris and strongyles. An outbreak of strongylosis in Camarines Sur Province was recorded in 1916 by Boynton and Wharton. Of the 90 animals in the herd reported, 69, or 76.7 per cent, died from intestinal parasites.

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[1] Experiment Station contribution No. 1253. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor Miguel Manresa.

Ascaris vitulorum Goeze is conceded to be the most common intestinal parasite of the young stock in the Philippines. Ransom (1911) intimated that this parasite seems to be more common in calves than in adults. He further recorded that oxen (*Bos taurus* L.) and Zebu (*Bos indicus* L.) are the definitive hosts of the parasite and that specimens have been collected in Europe, Japan, Ceylon, West Indies, Antigua, and Cuba. In the Philippines, Tubangui (1925) also established oxen and carabaos (*Bubalus bubalus* L.) as the definitive hosts of this parasite. Schwartz (1922) observed in Laguna Province cases of roundworm infestation in Indian cattle (Nellore), Indian buffaloes, and native carabaos. Clinical cases of ascariasis in carabaos, horses, and small animals in Laguna Province were reported by Koster and Ashcraft (1922). Gomez (1924) likewise reported clinical cases of cattle ascariasis in this province. According to Villegas (1932), more young carabao calves die from roundworm infestation than from any other disease, excluding infectious diseases.

In May, 1933, the writer made some fecal examinations of ten calves, with ages ranging from 27 to 60 days, picked at random in the stock farm of the Trinidad Agricultural School, La Trinidad, Benguet. Six calves averaging 32 days of age were found infested from moderate to heavy with roundworms, six for strongyles (stomach worms and nodular worms) and three for whipworms. Past observations in the Department of Animal Husbandry, College of Agriculture, indicate that a significant number of calves (oxen and carabaos) have died of internal parasites or from causes attributable to internal parasitism. A careful analysis of the animal records of the Department on the causes of deaths in calves from 1919 to 1933, inclusive, revealed three outstanding points: (*a*) that about 30 per cent of the total mortality cases resulted from internal parasites, (*b*) that mortality was high among carabaos (Philippine carabaos and Indian buffaloes), and (*c*) that deaths from parasitic infestation occurred regularly every year.

While the present methods of handling calves in the Department have reduced the percentage of mortality from internal parasites somewhat, it seems particularly important and timely to work out improvements or to determine wherein room for improvement still lies. Either the problem of management of the young stock or that of proper pasture management or a combination of both appears to be the opening through which effective parasite control can be instituted.

Objects of the experiment

The objects of the present problem were: (*a*) to determine just how soon ox and carabao calves become infested with *Ascaris vitulorum* when: (*1*) calves are kept in corrals during the day and allowed to follow their dams at night; (*2*) calves are kept in corrals at night and allowed to follow their dams during the day; (*3*) calves follow their dams at all times: dams are not flushed; (*4*) calves follow their dams at all times: dams are flushed at least once daily; and (*5*) calves are kept under no particular system (control). (*b*) To determine the therapeutic agents that will prove effective against *Ascaris vitulorum* with the least injury to the calves.

Time and place of the present work

This work was conducted in the Department of Animal Husbandry from August, 1931, to December, 1933, a period of two years and five months.

MATERIALS AND METHODS

Animals

A total of 48 calves, all belonging to the Department of Animal Husbandry, were used in these studies. The calves and the description of each appear in table 1. There were 27 ox calves, 23 grade or native, and 4 Indian Nellore, 15 grade or native carabaos, and 6 Indian buffaloes. Thirty-eight of these animals were included in the experiment when they were from 10 to 15 days old; 10 when they were 30 days or older. All the calves were released from the experiment when about six to nine months old.

Instruments and equipment

In the examination of the feces for determining the presence or absence of the eggs of parasites, the following instruments and materials were employed: Bausch and Lomb microscope, hand centrifuge, test tubes, centrifuge tubes, glass slides, cover glasses, brass spoon, pipettes, medicine droppers, stemless funnels, burette, stirring rods, brass sieves, test tubes brushes, and hospital gauze. A large carboy was used as the container of the formalin solution.

For drenching the calves a small long-necked bottle was used. Liquids and solutions were measured with a graduated cylinder or burette. Drugs in solid or powder form were accurately weighed in an equal arm balance. Manila ropes were used to tether some dams in the pastures and to lasso and restrain the calves for treatment. Calves which were confined during the day or night were kept in a pen in the dairy barn with a concrete floor or in a paddock adjacent to the barn.

Therapeutic agents

The following therapeutic agents were used: oil of chenopodium, oil of turpentine, calomel (mercurous chloride), tartar emetic (antimony potassium tartrate), resorcinol (resorcin), and carbon tetrachloride (tetrachlormethane). For solvents, adjuvants, and to minimize the irritating property of the drugs, raw linseed oil, coconut oil, and tap water were used. Formalin in 20 per cent solution was used for preserving and diluting the fecal material. Pearson's creoline in solution of about one per cent was used occasionally with sick animals as an internal antiseptic. Aromatic spirits of ammonia was given as a carminative and stimulant with some calves whenever its administration seemed warranted.

Systems of management of the calves

The calves used in this work were from the different herds of animals: the breeding herd, the Indian Nellore herd and the dairy herd. The number of calves employed in the different systems of management appear in table 2.

Calves were kept in corrals or pens during the day and followed their dams at night. This system was designated *A*, as shown in table 2. The calves of the dairy cows composed the animals under this system. Early in the morning between six and seven o'clock, the milkmen drove the dairy herd, oxen and carabao cows and their calves, from the dairy pasture into the dairy barn, the concrete floor of which had been flushed clean with water. The calves were immediately driven into a pen where they remained until the afternoon milking was completed. Silage and soilage were fed *ad libitum* to them in the morning and afternoon. The dairy cows received adequate amounts of silage after the morning milking. After this feeding, the cows were driven into a paddock close to the barn. At 1:00 p. m. the dairy cows were driven back to the barn for the afternoon milking. The carabao cows were well flushed with water, and the udders of the regular cows were wiped clean with a piece of wet cheese cloth each time before they were milked. The calves were allowed to suckle the cows to start the milk flow or stimulate milk secretion before milking commenced. Between 4:00 and 5:00 p. m. the milkmen drove the herd back to the pasture.

The dairy herd pasture is divided into four lots. Rotation of pastures was practiced, the herd grazing in one lot for a period of ten days during the dry season and one month during the rainy season. The average time the herd remained in each lot was two weeks.

Calves were kept in corrals at night and followed their dams during the day. This system was designated *B*. The cows used in this system were tethered in the pasture; they were moved at least twice a day. They were watered in the morning, at noon, and in the evening. Between 6:00 and 7:00 p. m. the calves were caught and corraled in a pen in the barn where they passed the night. Between 6:00 and 7:00 a. m. on the following day, they were liberated and allowed to follow their dams.

Calves followed their dams at all times; dams were not flushed. This system was designated *C*. The dams were tethered in the pasture and moved at least twice daily. They were watered three times a day, morning, noon, and evening. The calves remained with their dams at all times. The dams were not flushed.

Calves followed their dams at all times: dams were flushed at least once daily. This system was designated *D*. The calves followed their mothers at all times in the pasture or paddock where the dams were tethered or turned loose. The tethered cows were moved at least two times daily and watered three times a day. They were taken to the dairy barn and flushed there. The cows' udders and hindquarters were flushed only once daily at noon, while the carabao cows were flushed twice daily, in the morning and afternoon. Some of the cows used in this system were dairy animals, but their calves were allowed to follow them at all times.

Control lot. This system was designated *E*. No particular system was followed in the management of the animals used as control. They were picked at random from any herd for fecal examination, and when roundworm infestation was observed, no treatment was administered. Daily egg count, however, was continued until consistent negative fecal examinations were obtained.

Frequency of fecal examination

The general procedure of making fecal examinations for detecting the presence or absence of parasite eggs conducted for the calves in all the systems of management follows:

1. Daily examination for two weeks
2. Daily examination continues indefinitely when infestation is observed until consistent negative results are established.

3. Four-day interval examination for the following two weeks or after daily examinations become negative
4. Seven-day interval examination during the following two months
5. Fifteen-day interval examination for about five months or more

Soon after the *Ascaris vitulorum* infestation was definitely established, the administration of the drug was begun and daily fecal examination continued until the microscopic examinations remained consistently negative. This procedure was necessary in order to determine the approximate degree of infestation and the relative anthelminthic efficacy of the drug used. After the microscopic examinations had proved consistently negative, the examinations during the four-, seven-, and fifteen-day intervals were adhered to unless subsequent reinfestation occurred, in which case the daily examination was resumed.

Fecal examination

The method developed by Hall (1911) in examining feces for eggs of parasites was followed with certain modifications. The modified method consisted of putting the fecal material through the processes of comminuting or breaking, sieving, and centrifuging. A small sample of the feces of each animal was obtained from the pen, corral, pasture or wherever the calf was found. It was often necessary to watch the calf defecate, and this failing, the animal was caught and a sample was obtained from the rectum. With proper methods used, the calves could be induced to pass feces. Each sample was wrapped with a clean piece of Manila paper and then taken to the laboratory.

With a small brass spoon, a measured amount was scooped from the interior of each lump sample, clearing any excess by scraping it off with a glass slide. Hard feces were first broken up before the measured amount was taken. The measured fecal material was immersed in a test tube containing 7 cc. of 20 per cent formalin solution and there comminuted as much as possible with a glass stirring rod. To eliminate the coarse fecal particles and the non-parasitic materials the formalin-feces solution was screened directly into a centrifuge tube through a double sieve. This consisted of a brass sieve with eight meshes to the linear centimeter (20 meshes to one inch) and a hospital gauze of three to four layers. The resulting solution was centrifuged for one minute at the average rate of about 2,000 r.p.m. The supernatant liquid was drawn up with a 10-cc. pipette, leaving approximately two cubic centimeters in each centrifuge tube, just sufficient to form a concentrated solution. The remaining mixture was stirred thoroughly with a medicine dropper each time before a drop was taken for microscopic examination.

Ten drops from each sample were examined and the average constituted the determination for the sample on any particular day.

To prevent contamination clean materials were used in wrapping the samples taken to the laboratory; the small quantity of feces for examination was taken from the inside of the lump sample; samples were often secured directly from the rectum of the animal; the glass instruments, brass sieves, and brass scooper were thoroughly rinsed with soap and clean water each time they were used; and the gauze sieve was used only once.

Administration of drugs

The different drugs were administered as drench, except carbon tetrachloride which was given in capsules. Preliminary treatment, such as fasting, feeding, purgation, or the like, was not practiced. The infested calves were treated individually soon after parasitic infestation was definitely determined. The drench was usually given to the dairy calves in the afternoon after milking was completed and to other calves any time of the day.

In administering the drench the animal was backed into a corner or against any convenient barrier and held there in a natural standing position. To control and keep the calf in place, the operator straddled over the neck of the animal. With the left hand holding the lower jaw the head was slightly raised to a position almost parallel to the body of the calf. To open the mouth of the calf the left thumb was inserted at the left corner. The neck of the drench bottle was introduced at the right corner of the calf's mouth, bringing the mouth of the bottle as far back on the tongue as possible. The bottle was gradually tipped to allow the medicinal preparation to flow slowly in small amounts. It was found satisfactory to withdraw the bottle each time after a sufficient quantity was poured to permit swallowing and avoid waste.

With strong calves a short rope was tied around the neck and then fastened at the rear. For exceptionally stubborn carabao calves it was necessary to tie neck and body securely against a wall or fence before the treatment. But when they became used to handling, this restraint was not necessary. For older animals a slightly different method of restraint was adopted. The calf was backed into a corner and then shifted against one side of the wall to a natural standing position. It was kept there by the operator by placing his left leg forward against the chest and right shoulder of the calf and his leg to the rear so that his back was turned halfway towards the animal and by holding the neck under his left shoulder.

In administering carbon tetrachloride capsules the method of restraint described in the preceding paragraphs was followed. The capsule was dropped as far back on the tongue as possible and immediately followed by about 100 cc. of tap water.

Dosage and frequency of treatment

The drugs tested, their dosages and methods of administration, together with the number of calves treated, appear in table 3.

Oil of chenopodium. The calves received repeated daily doses of this anthelminthic. The dose during the first week was 2 cc. diluted in 30 cc. of coconut oil. Each succeeding week thereafter the dose was increased by one cubic centimeter until the microscopic examinations proved negative or showed an egg count low enough to warrant discontinuing the treatment. The quantity of the coconut oil used subsequently with each dose remained constant.

Oil of turpentine. A few days after infestation was determined, the calf received daily for seven days a dose of 2 cc. combined with 30 cc. raw linseed oil. This dose was increased by one cubic centimeter every week thereafter, the amount of raw linseed oil remaining constant. Treatment was stopped when the examinations became negative or showed a positive low parasite-egg count.

Calomel. For a single dose, 0.5 gram of calomel was given daily during the first week, and each succeeding week the amount was increased by 0.5 gram. The calomel in powder form was triturated and dissolved in 100 cc. of fresh milk, this quantity used as adjuvant remaining constant throughout.

Tartar emitic. Single doses administered daily during the first week consisted of 0.5 gram dissolved in 50 cc. of tap water. Every week thereafter the amount of tartar emetic was increased by 0.25 gram while the water remained constant. These dosages were established after a preliminary treatment in which the calves received much smaller doses. The treatment of the animal continued until evidences of parasitic infestation were negative.

Resorcinol. The treatment for the first week in repeated doses consisted of one gram dissolved in 50 cc. of tap water. An increase of one gram each week thereafter was followed, the amount of water remaining constant. The first subject treated was given a preliminary dose of 0.5 gram daily for three days.

Carbon tetrachloride. Doses of one capsule containing 20 minims, or approximately 1.25 cc., were given on alternate days for the first week. The number of capsules was increased by one every week thereafter until fecal examinations proved negative.

RESULTS AND DISCUSSION

Age of calves when fecal examination disclosed Ascaris infection

Various investigators on parasites and parasitic diseases state that young growing animals suffer most from internal parasitism. But, from literature available, apparently little has been done to determine the age when infection occurs or when infestation becomes evident under natural conditions or within actual field limitations. Controlled studies on the life histories of *Ascaris* species have been carried out on experimental animals largely through artificial infection. The question that arises, therefore, is: When do calves generally become infested with *Ascaris vitulorum* under field conditions?

As affected by the system of management. The data here reported show that under system *A* (calves were kept in corrals during the day and followed their dams at night), the calves became positive for ascaris at the average age of 23.9 days; oxen, 35.1 days and carabaos, 22.4 days. Under system *B* (calves in corrals at night followed their dams during day time) ox and carabao calves were found positive at the average age of 25 days. In system *C* (calves followed their dams at all times; dams not flushed), the ox calves became positive 24.5 days after birth. With system *D* (same as system *C*, except that dams were flushed once daily) the infestation became evident 21.5 days after birth, 23.5 days for oxen, and 19.5 days for carabaos. In systems *A* and *D* the carabao calves showed infestation about four days earlier than ox calves. In the control lot, *E*, the calves became positive at the average age of 22.9 days; oxen, 25.8 days; and carabaos, 19 days. The calves in all systems were found positive 23.3 days after birth; oxen, 25 days; and carabaos, 21.6 days. The carabaos became positive for ascarids four days earlier than oxen. These results indicate that carabao calves are more susceptible to earlier infestation than ox calves.

The average ages of calves when infestation was first established were 23.9 days for system *A*; 25.0 days for *B*; 24.5 days for *C;* 21.5 days for *D*; and 22.9 days for the control lot. For oxen the averages were 25.1 days for system *A;* 25.0 days for *B*; 24.5 days for *C;* 23.5

days for *D;* and 23.5 days for the control. The averages for carabaos were 22.4 days for *A;* 25.0, for *B;* 19.5, for *D;* and 19.0 for the control. These results show only slight differences and do not indicate any decided advantage of one system of managing calves over another in preventing or controlling parasitic infection or infestation. In fact, the systems, *A, B, C,* and *D,* were not any better than the control lot, *E.* The striking fact is that in all systems *Ascaris* infestation was detected.

Undoubtedly, live stock raisers employ some systems of management as preventive measures in combating internal parasites. These practices are, however, largely empirical. On large ranches where effective herd management and mass production are important, the control of parasites receives inadequate attention. In the Philippines where small individual ownership of live stock prevails, the management of the young stock should prove beneficial in controlling parasites and parasitic diseases. The results just presented on this phase are not encouraging. One system, in which the calves were kept shut in at night and followed their dams during day, gave promising results, although it was not decidedly better than any of the other systems tried. Perhaps better results would have been obtained if the management of pastures was correlated with the management of calves. From his observations on ranching in Bukidnon, Manresa (1930) recognized pasture management as a method of controlling parasites.

The four systems and control lot compared. A comparison of the results in all the systems (*A, B, C,* and *D*) and those in the control lot, *E,* indicated no marked advantage in management in preventing early infection. The managed calves and those in the control lot averaged 23.5 and 22.7 days, respectively; oxen, 24.5 and 25.7 days; and carabaos, 22.3 and 19 days. In fact, the managed carabao calves appeared to be a trifle better than the unmanaged ones. In this experiment no attempt was made to prevent the contamination of pastures where all the calves had free range and this may explain the apparent ineffectiveness of the systems employed in controlling parasites.

Age of infection. After the age when infestation had been established this question arose: At what age did these calves actually pick up infection, that is, when were the infective eggs of *Ascaris vitulorum* ingested by the calves? Unfortunately, there appears to be no available literature on the complete life history of this parasite. If the sexual maturity of *Ascaris vitulorum* were known, then it would be possible to count back from the time infestation was first found in order to determine the age of infection. Observations on this parasite made by Schwartz (1922) seem to indicate that under climatic conditions prevailing in the Philippines *Ascaris vitulorum* should complete its life cycle in less time than noted in colder countries and in other related species. According to Ransom and Foster (1920), in pigs and human beings *Ascaris* may develop to maturity within two and one-half months after infection. From his studies with *Ascaris lumbricoides*, Martin (1926) concluded that in pigs, *Ascaris* may develop to maturity as early as 49 days after the ingestion of infectious eggs. Schwartz, *et al.* (1930) stated that the horse ascarid (*Ascaris equorum*) develops to maturity in about two to two and a half months. With the stomach worm, *Haemonchus contortus* (Cobb.) in sheep and goats, Hardy and Schmidt (1932) found that this parasite reaches sexual maturity within nine to eleven days in the host and the mature female begins to lay eggs, so that an animal heretofore clean will pass stomach-worm eggs in its droppings as early as the eighteenth day after taking up infective-worm larvae.

It appears from the preceding discussions, therefore, that the infection of the calves may have occurred soon after they were able to suckle the udder of the dams or soon after they became old enough to nibble grass and drink water in infested pastures. Intrauterine infection as possible explanation was disproved by Martin (1926).

Relative efficacy of drugs

The success of most medications with drugs against internal parasites in different animals is usually expressed in terms of percentage. The critical tests for determining the percentage of efficacy of anthelmintics, according to Hall and Shillinger (1924) are established by administering the drugs in definite known doses to animals, with subsequent collection for a suitable length of time of all worms passed and the post-mortem examination of the animals with the collection of all worms then present. Identification of the worms collected ante-mortem and post-mortem and addition of the numbers of those of the same kind give the total number of each kind present at the beginning of the experiment. The relation of the number of each kind passed to the total number present at the beginning of the experiment is expressed in percentage and this is arbitrarily regarded as the percentage of efficacy of the anthelmintic. In the present work this procedure was not found applicable, so that other means were employed to determine only the relative efficacy of the drugs used.

The following were adopted as the criteria for determining the relative effectiveness of drugs. (a) The duration of observed infestation means that period elapsing from the time fecal examination became positive up to the time this examination showed negative results. The results obtained with the different drugs and those with no treatment were then compared as to the length of time. (b) With the relative degree of infestation as a test of efficacy, the following figures and their connotation with regard to the maximum average egg count were arbitrarily chosen: 50 eggs or less, very light; 50 to 100 eggs, light; 100 to 200 eggs, mild; 200 to 300 eggs, heavy; 300 eggs and over, very heavy. (c) The number of repeated treatments was also used in measuring efficacy. (d) The effects of the drug on the calves was likewise taken as a test of efficacy.

On the basis of the results obtained the different drugs were classified as follows: very effective—carbon tetrachloride; fairly effective—oil of chenopodium; ineffective—oil of turpentine, tartar emetic, resorcinol and calomel; injurious in repeated daily doses—calomel and tartar emetic. When the duration of observed infestation of the calves treated with each drug was taken individually or collectively and then compared with that of the untreated calves, the rank of the therapeutic agents in the order of descending effectiveness follows: carbon tetrachloride, oil of chenopodium, oil of turpentine, tartar emetic, calomel, and resorcinol. On the basis that an agent of some value should expel some or most of the worms during the infestation period and therefore reduce infestation to the minimum as revealed by microscopic examination, the drugs may be arranged in the order of their descending value: resorcinol, tartar emetic, oil of turpentine, carbon tetrachloride, calomel, and oil of chenopodium. It appears that although resorcinol, tartar emetic, and oil of turpentine kept down infestation to a moderate degree, they failed to free the animals as early as carbon tetrachloride and oil of chenopodium. According to the number of repeated doses administered until the calves showed reduced infestation, the order from the least to the highest follows: carbon tetrachloride, oil of turpentine, tartar emetic, oil of chenopodium, calomel, and resorcinol.

In point of time, economy, and ease of administration carbon tetrachloride proved to be the best.

Oil of chenopodium. In a total of eight treatments, oil of chenopodium was found fairly effective in four cases, effective in two, and ineffective in two. Five days after the last dose was given, calf No. 30 (Indian buffalo) died at the age of 97 days of ascariasis, with complications directly traceable to the drug. It received a total of 187 cc. in repeated doses of from 2 to 6 cc. during a period of 52 days. It was found negative at the age of 63 days but when reinfestation occurred 12 days later treatment was again given and continued for 17 days. Living ascarids in the bowels were seen at necropsy. Calf No. 218 (ox) became free at the age of 39 days after 17 days of treatment in which a total of 26 cc. was given. When 55 days old, or 16 days later, reinfestation occurred and the treatment was resumed for 24 days, during which a total of 55 cc. was administered. The calf became negative when 79 days old. These results seem to show that individual tolerance of animals may affect the effectiveness of chenopodium.

With other species of animals this drug has been found very effective for roundworms. Hall and Foster (1918) found oil of chenopodium the most reliable vermifuge for ascarids in dogs and swine. Mote (1924) reported that it has some anthelminthic efficiency against ascarids in hogs under experimental conditions. Oil of chenopodium is recommended by Hadley (1932) as the best anthelminthic for *Ascaris* in swine. The present results do not seem to demonstrate that this drug is very efficacious for ascarids in oxen and carabao calves. It has some anthelminthic value, however, and further trials with it in these animals may be warranted.

Carbon tetrachloride. In eight treatments with this anthelminthic, four proved very effective, two effective, and two fairly so. In all the cases treated, it successfully eliminated the parasites in the least time and with the least number of repeated dosages. Among the superficial symptoms associated with its use in cattle and carabao calves were dizziness, dullness, weakness, and wobbly gait. These were observed on the day following the dose and were temporary effects only. No deaths resulted from its use. It appears that carbon tetrachloride is an efficient anthelminthic for roundworms in cattle and carabaos. With other classes of live stock it has been found to be very effective against ascarids and other internal parasites. Schwartz *et al* (1930) reported that experiments indicate that carbon tetrachloride is very effective for the removal of ascarids in horses. Hall and Shillinger (1923) claim it to be extremely effective in removing stomach worms, nodular worms, and whipworms. Willard and Bozicevich (1931) reported carbon tetrachloride to be somewhat effective against stomach worms and hookworms in sheep, but they concluded that sheep can not be safely treated once a week with this drug. Hall (1921) and Hall and Shillinger (1923) stated that it is very efficacious against ascarids in dogs.

Oil of turpentine. Four calves were treated with this drug and the treatment appeared somewhat effective in one calf. Calf No. 96 (carabao) died of ascariasis when 49 days old while under treatment, having received a total of 89 cc. of turpentine in repeated daily doses of from 2 to 5 cc. for a period of 24 days. Calves Nos. 207 and 211 (oxen) were treated when the infestation was apparently diminishing with the increasing age of the animals, so that the effect of treatment could not be attributed solely to it. It may be concluded from these results that turpentine is ineffective against ascarids in cattle and carabaos. According to Milks (1930), turpentine is a fairly efficient anthelminthic, especially against roundworms. Its use against ascarids in other animals has been found unsatisfactory. Hall and Foster (1918) found it decidedly inefficacious against ascarids in swine and dogs, causing nephritis in the former.

Tartar emetic. The results from the treatment of four calves with this drug were not encouraging. Calf No. 222 (ox), which was in excellent condition, received the initial dose when infestation was already at its maximum (table 6) and became subsequently clean at the age of 59 days. Calf No. 61 (Indian Nellore) died when 78 days old of hemorrhagic nephritis attributed to tartar emetic. This animal received a total of 35 grams in repeated doses of from 0.5 gram to 1.5 grams for a period of 35 days. Calves No. 227 (ox) and No. 32 (Indian buffalo) were treated and eventually became negative, but the duration of infestation was not far from that of the control lot. White (1920) recommends tartar emetic against roundworms in cattle. With other classes of live stock this drug is used. It is recommended by Underhill (1920) and Hadley (1932) for ascarids in horses. The present results do not seem to justify its use against *Ascaris* in oxen and carabaos.

Resorcinol. It was used with three calves and proved to be quite effective in one. Calf No. 103 (carabao) became free after 27 days of infestation, having received the drug for a period of 23 days. The two other calves became subsequently free but the infestation persisted just as long as in the untreated animals although it was very light. It appears from these results that as an anthelminthic against ascarids in oxen and carabaos, resorcinol is not promising.

Calomel. This drug was tried with only one animal and was found very ineffective against ascarids in cattle. Moreover, it caused severe hemorrhagic nephritis, resulting in the death of the calf. A total of 41 grams was administered in repeated small doses of from 0.5 gram to 2.5 grams during a period of 30 days. The animal showed a progressive loss of condition and general anemia. These conditions may also be attributed to the parasites. The infestation during the course of fecal examination was heavy and lasted as long as in the untreated animals. Because of its harmful effects no other trials with calomel were attempted. This drug is recommended by Milks (1930) for roundworms. The results obtained with it were not encouraging.

Age of calves when fecal examination became negative

A gross comparison of the effects of treatment and no treatment as regards the persistence of infestation and the age when the calves became negative revealed that the average age when negative examination became evident was 60 and 81.3 days for treated and untreated calves, respectively. The treated animals were free about 21 days earlier than when no treatment was administered.

With oxen and carabaos taken separately, the average age for treated and untreated cattle was 63.7 and 89 days, respectively; for treated and untreated carabaos, 54.8 and 73.5 days, respectively. Treated oxen became free 26 days earlier than those in the untreated lot. Carabaos that received treatment were negative 19 days earlier that the untreated ones. These results indicate that the treatment reduced the duration of infestation, thus minimizing injury from the parasites. With calves that were found already positive the average age when they became negative was 72.4 days, or 75.6 and 67.5 days for oxen and carabaos, respectively. At the beginning of the experiment these calves ranged in age from 30 to 62 days as the treatment was administered at this time; this accounts for the wide range of variation in the results obtained. These data, nevertheless, are in agreement with the preceding results.

Occurrence of reinfestation

Follow-up fecal examination at regular intervals, from the time negative results were observed up to about nine months thereafter, was made. This procedure was followed in order to detect subsequent reinfestation.

Examination of calves that became infested and subsequently negative. The data show that the calves remained negative six and one-half months after they had been freed from the parasites. The average for oxen and carabaos was about seven and six months, respectively. Calf No. 30 (Indian buffalo) was found negative at the age of 63 days, became reinfested when 75 days old, and died at the age of 97 days positive for roundworms. Ox calf No. 218 became negative at the age of 39 days, was reinfested 16 days later, and became negative again when 79 days old. These reinfestations occurred during the third month after birth and beyond this period no other subsequent reinfestations were detected.

Examination of calves found already infested and subsequently freed. During the course of about eight months the oxen and carabaos were examined and found free. The calves showed no subsequent reinfestation.

Examination of calves found not infested during the course of the experiment. It may be seen that these animals did not become positive from the time they were used up to the end of fecal examination. They were last examined and found still free at the average age of about seven months, the age ranging from about four to ten months. These data indicate that after the calves had passed the age of four months reinfestation with *Ascaris vitulorum* is less likely to occur. Before that period reinfestation may terminate in the death of the animal.

Relation of age to infection and infestation

From the foregoing data there appears to be a certain age limit or period during which calves are highly susceptible to *Ascaris vitulorum* infection and infestation. The data already presented reveal that in calves the greatest susceptibility to infection occurred during the first three weeks after birth. The infestation was detected from the third to the fifth week of life. The oxen and carabao calves became positive at ages ranging from 21 to 35 days and 17 to 32 days, respectively.

The duration of observed infestation, as already defined, covered that period when fecal examination became positive until it subsequently became negative. With the effects of treatment barred, the period of infestation in oxen and carabaos varied from 15 to 66 days and 14 to 68 + days, respectively. Oxen and carabaos were free at ages varying from 40 to 104 days and 40 to 97 + days, respectively. Three carabao calves that died of ascariasis were 49, 35, and 97 days of age, respectively. One ox calf died of nephritis when 78 days old. These animals were found positive for roundworms by fecal and post-mortem examinations.

It may be seen from the foregoing results that ascariasis is confined to calves below approximately three to three and a half months of age, and that *Ascaris* infestation may remain in the host from one-half month to two and a half months. On the average, the infestation may persist in the host a little over a month in treated calves and about two months in untreated ones. Villegas (1932) reported cases of fatal ascarisis in Philippine carabaos, Indian buffaloes, and grades, the average age of eight animals at death was 47 days, the range being from 21 to 67 days. He further states that, in general, carabao calves are safe from this disease beyond the second month. It would seem from the foregoing that infestation, if it occurs beyond the age limits found in the present experiment (3 to 3½ months), will probably not greatly affect the health of the calves.

Relation of condition, resistance, and immunity to infection and infestation

Many calves were found not infested with parasites at the start and remained free during the course of the experiment. The fecal examinations were made every day for two weeks; after that, every four days for two weeks more; every 7 days for 2 months; and thereafter, every 15 days until the calves completed one year of age. This finding is remarkable in that the calves remained free from *Ascaris* although they were in daily contact with the other infested calves in the same herd or pasture. Six calves were observed when from 10 to 15 days of age and one at the age of 41 days. With the exception of calf No. 65, which suffered from a foot injury, these animals were in good condition during the first three months after birth. It appears that calves in good condition may succeed in warding off infection even if placed in contaminated areas. Boncato (1932) found that liberal feeding with grain supplement produced the best results in promoting good health and in reducing stomach and intestinal worms in sheep and goats. Condition alone can not, however, be the sole explanation for the non-infection of the calves. It is possible that an inherited quality to resist *Ascaris vitulorum* infection exists in much the same way as resistance to certain other animal diseases.

The subject of immunity has been studied by several investigators. Martin (1926) cited Stewart (1916) who suggested that there was a possibility of one infection preventing a subsequent one. He also stated that he had never observed worms of obviously different ages associated together in the intestines of pigs. Ransom and Foster (1920) suspect that age is the determining factor in the lessened susceptibility of pigs to *Ascaris* rather than any acquired immunity as a result of a previous infection. They concluded from their experiment that if an immunity is established as a result of a previous infection it is not acquired immediately. In the present experiment there were two calves that became reinfested after having been found to be negative [calf No. 218 and calf No. 30 (Indian buffalo)]. These two cases appear to confirm the contention of these investigators that if immunity is established at all, it is not acquired immediately. It seems probable, therefore, that the age factor has something to do with the increased resistance and lessened susceptibility of animals to infection or infestation as they grow older.

Internal parasites and parasitism in calves

Long after the roundworms were eventually expelled, either through the effect of anthelminthics or under natural sterilization, other parasites were observed through fecal examination. Many of the calves used in this work harbored other internal parasites besides ascarids. Of the total number of 48 calves, 25 per cent harbored roundworms only and 10 per cent were infested with roundworms and stomach worms together. The incidence of infestation with each of the following was 8 per cent: stomach worms alone; ascarids and whipworms together; and roundworms, stomach worms, nodular worms and whipworms together. Two calves (oxen) harbored four or more parasites simultaneously.

Ascaris vitulorum was found in 39 calves constituting 81 per cent. Of this number 23 were oxen and 16, carabaos. Calves harboring stomach worm (*Haemonchus contortus*) constituted 48 per cent (13 oxen and 10, carabaos); nodular worm (*Oesophagostomum* sp.), 35 per cent. Only two calves were found infested with cattle hook-worm (*Bunostomum phlebotomum* Railliet). Nineteen calves, or 40 per cent, were positive for all other parasites. Boynton and Wharton (1916) recorded and identified the following common parasites in cattle that died of infestation in Camarines Sur: cattle hookworm, stomach or wire worm, nodular worm (*Oesophagostomum* sp.), and whipworm (*Trichuris ovis* [Abildgaard] Smith). Unpublished data on the identification of some intestinal parasites from calves that died in the Department of Animal Husbandry are as follows: cattle hookworm (*Bunostomum phlebotomum*), *Nematodirus* sp., and nodular worm (*Oesophagostomum* sp.). Working on the metazoan parasites of Philippine domesticated animals, Tubangui (1925) enumerated, among many others, the following: *Ascaris vitulorum, Trichuris ovis, Haemonchus contortus, Oesophagostomum columbianum* Curtice, and *Bunostomum phlebotomum*. It is obvious from these results that *Ascaris* is the most common internal parasite of young oxen and carabaos and that ascariasis seems to be a serious problem which demands considerable attention.

Mortality record

Altogether twelve calves died of various causes; ten during the course of the experiment and two soon after. Of this number four were oxen and eight were carabaos (Philippine carabaos and Indian buffaloes).

Five carabaos died of heavy parasitic infestation, three of ascariasis at the average of age of 60 days, and two of strongylosis at the average age of 223 days. Calf No. 98 (carabao), which died of ascariasis when 35 days old, received no treatment. It may be mentioned that all the animals that died of internal parasites were in extremely poor condition. With the exception of calf No. 61 (Indian Nellore), which was in good condition, all calves that died were below normal in condition. Calves Nos. 60 and 61 (Indian Nellores) died of hemorrhagic nephritis directly traceable to calomel and tartar emetic, respectively. Post-mortem examination of calf No. 60 revealed both kidneys greatly enlarged, hemorrhagic, and covered with fat and the flesh anemic. In calf No. 61 the kidneys were greatly enlarged, friable, and severely hemorrhagic, and the intestines showed hemorrhagic inflammation. Two calves (oxen) died from suspected forage poisoning. Three carabaos died from other causes: general physical debility, pneumonia with general anemia, and accident (fell into a creek).

Post-mortem examination of the digestive tract of the animals showed the presence of four common species of parasites;[2] namely, roundworm (*Ascaris vitulorum*), stomach worm (*Haemonchus contortus*), nodular worm (*Oesophagostomum* sp.), and whipworm (*Trichuris* sp.). One ox calf was butchered and found positive for hookworm (*Bunostomum phlebotomum*). The presence of these parasites was also established by fecal examination before the animals died. Calves Nos. 96 and 98 (carabaos) showed the presence of adult ascarids that completely occluded the small and large intestines, numbering 268 in the former. Three treated carabao calves, all over 72 days old, disclosed no roundworms upon necropsy but were positive for strongyles. Stomach worms were found in the paunch of calf No. 32 (Indian buffalo). One untreated carabao calf that died when 166 days old revealed nodular worms but no roundworms. The foregoing data shows that ascariasis is a disease of young calves, while strongylosis affects older calves.

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[2] Identifications on worms collected were made by Dr. Zacarias de Jesus of the College of Veterinary Science.

Observation on some symptoms of infestation

Condition of animals. It was noted in most cases that when heavy roundworm infestation occurred it rendered the calves gradually poorer in condition. Prolonged heavy infestation reduced the animals to an emaciated condition. The most noticeable symptoms were irregularity or complete loss of appetite and general weakness. Dullness and in some cases convulsions occurred. The pot-bellied condition was noted in carabao calves harboring a heavy infestation of strongyles.

Condition and color of feces. Infested carabaos usually evacuated with great difficulty sticky, foul-smelling feces, sometimes dark and sometimes light in color. Cattle were often constipated. Bloody feces were occasionally encountered. Villegas (1932) observed that feces of infested carabao calves appear whitish.

Appearance of coat. In carabao calves the coat became coarse, dry, and shaggy. This was not so noticeable in ox calves. It was observed that among the carabaos the hair about the withers, neck, and shoulders dropped off until these parts became almost bare. A new growth developed after infestation began to diminish.

SUMMARY AND CONCLUSIONS

1. None of the four systems of managing calves studied was effective in preventing infection by internal parasites.

2. None of the drugs tested was found uniformly effective. In the order of their descending effectiveness the results were: carbon tetrachloride, oil of chenopodium, oil of turpentine, and resorcinol. Calomel and tartar emetic were found to be positively injurious to the health of the calves.

3. The average age at which the calves in the four systems of management were found positive for *Ascaris vitulorum* Goeze was

23.3 days; oxen, 25 days; and carabaos, 21.6 days. Carabao calves showed infestation at an earlier age than oxen calves.

4. In calves that received treatment the average period of *Ascaris* infestation persisted in the host a little over one month, while in untreated calves it remained for about two months.

5. The calves were receptive to *Ascaris* infection during the first three weeks of life; and as they approached the third month, if they survived the infestation, they developed some degree of resistance and became refractory thereafter.

6. The condition of the calves aided greatly in warding off or reducing infestation, but this alone could not explain the non-infection of some animals. It was found that some calves did not become infected; they remained free from infestation although they were kept in the same pasture with the infected calves.

7. The internal parasites found in oxen and carabao calves were: roundworm (*Ascaris vitulorum* Goeze), stomach worm (*Haemonchus contortus* [Cobb.]), nodular worm (*Oesophagostomum* sp.), whipworm (*Trichuris* sp.), and ox hookworm (*Bunostomum phlebotomum* Railliet).

8. Ascariasis was found to be a disease of young calves, causing high mortality, particularly in carabaos. Strongylosis was found to affect relatively older calves.

9. The symptoms of ascariasis in carabaos were: dullness, poor appetite, general weakness, convulsions, rapid loss of condition; feces sticky, mud-like, foul-smelling, whitish or yellowish, and watery or very soft; hair coarse, dry and shaggy; loss of hair on withers, shoulders, and neck. The pot-bellied condition was observed in carabao calves affected with strongylosis. Among cattle calves the symptoms were: listlessness, irregularity of appetite, weakness, constipation, occasionally light, soft or watery feces, loss of glossiness of the coat, and a progressive gradual loss of flesh. These symptoms may be manifested at the same time or at different times during the infestation.

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TABLE 1

Calves used in the experiment

CATTLE

SERIAL NO. OF CALVES	SEX	BREEDING	AGE WHEN	
			used	discarded
			days	*days*
205	Female	Crossbreed	98	280
207	”	”	44	64
211	Male	”	62	337
212	”	”	55	66
213	”	”	32	43
214	Female	”	15	292
217	Male	”	14	307
218	”	”	12	312
219	”	”	12	293
222	Female	”	30	292
223	Male	”	14	256
224	Female	”	15	74
225	”	”	15	308
226	Male	”	15	326
227	Female	”	15	304
228	”	”	13	275
229	Male	”	15	273
232	”	”	12	282
236	”	”	13	310
243	Female	”	15	169
246	”	”	15	105
247	Male	”	15	43
283	Female	Native	10	134
60	”	Indian Nellore	15	78
61	Male	” ”	13	78
62	Female	” ”	15	279
65	Male	” ”	13	135
CARABAOS				
95	Male	Grade	115	312
96	”	”	12	49
97	”	”	50	302
98	”	”	14	35
99	”	”	12	291
100	”	”	15	320
101	Female	”	46	287
102	”	”	15	294
103	Male	”	15	278
104	”	Native	15	166
105	Female	Grade	15	301
106	”	”	10	72
110	”	”	14	286
112	”	”	14	106
113	Male	”	15	82
29	”	Indian buffalo	41	283
30	”	” ”	14	97
31	”	” ”	15	275
32	Female	” ”	12	153
33	Male	” ”	15	257
36	Female	” ”	10	102

TABLE 2

Calves used in the different systems of management

SYSTEMS OF MANAGEMENT	CATTLE			CARABAOS			TOTAL
	Native	Indian Nellore	Crossbreeds	Native	Grades	Indian buffaloes	
	number	*number*	*number*	*number*	*number*	*number*	*number*
A—Calves kept in corrals during day and followed their dams at night		2	8		7	5	22
B—Calves kept in corrals at night and followed their dams during day		2	2		2		6
C—Calves followed their dams at all times; dams not flushed	1		5		1	1	8
D—Calves followed their dams at all times; dams flushed at least once daily			3		2		5
E—Control: calves kept under no particular system			4	1	2		7
Total	1	4	22	1	14	6	43

TABLE 3

Drugs tested, their dosages, methods of administration, and number of calves treated

DRUGS TESTED	WEEKLY DOSAGE (GIVEN DAILY; CARBON TETRACHLORIDE GIVEN ON ALTERNATE DAYS.)					METHODS OF ADMINISTRATION	CATTLE		CARABAOS		TOTAL
	First	Second	Third	Fourth	Fifth		Indian Nellore	Grades	Grades	Indian buffaloes	
	ml.	*ml.*	*ml.*	*ml.*	*ml.*		*number*	*number*	*number*	*number*	*number*
Oil of chenopodium ...	2.00	3.00	4.00	5.00	6.00	By drenching; diluted in 30 ml. of coconut oil		3	5	2	10
Oil of turpentine	2.00	3.00	4.00	5.00	6.00	By drenching; combined with 30 ml. of raw linseed oil ...		3	1		4
Carbon tetrachloride ..	1.25	2.50	3.75			In soft gelatine capsule; each followed immediately by about 100 ml. of tap water	1	4	3		8
	grams	*grams*	*grams*	*grams*	*grams*						
Calomel	0.50	1.00	1.50	2.00	2.50	By drenching; dissolved in 100 ml. of fresh milk	1				1
Tartar emetic	0.50	0.75	1.00	1.25	1.50	By drenching; dissolved in 50 ml. of tap water	1	2		1	4
Resorcinol	1.00	2.00	3.00	4.00	5.00	By drenching; dissolved in 50 ml. of tap water		2	1		3
Total							3	14	10	3	30

DETERMINATION OF THE FERTILIZERS AND FERTILIZER MIXTURES SUITABLE FOR AN UPLAND RICE[1]

DEMOCRITO TOPACIO

WITH FOUR TEXT FIGURES

In pot cultures supplied with varying amounts of ammonium sulfate, Libatique (1931) found that as the rice plants grew older, the yield of top increased with the age of the plant. Adverse results were obtained, however, with the roots, for it was found that at the age of 90 days, the plants grown in Lipa clay loam and supplied with 43.48 grams of the fertilizer produced relatively large tops and strikingly small root systems. The most beneficial amount of ammonium sulfate for rice plants grown to maturity in the same soil appeared to be 5.43 to 13.91 grams per 625 square centimeters of soil surface.

Varying the amounts of ammonium sulfate produced other characteristic effects upon the rice plant grown in Lipa clay loam in pot cultures. Soriano (1934) found that the rice plant produced dark green leaves, and as the amount of the fertilizer was increased, the chlorophyll content of the leaves gradually but steadily increased. Almeda (1937) showed that the total ash content of tops increased with the age of the rice plant and with the amount of ammonium sulfate used, but the percentage of ash diminished with age and with the amount of the fertilizer used. He also found that as the rice plants grew older, and as they received more ammonium sulfate, more dry matter was produced. He observed that the optimum application of ammonium sulfate fertilizer on Lipa clay loam was 7.06 grams per pot, or at the rate of 1½ tons per hectare.

Other fertilizer studies with the rice plant were made, but most of these dealt with other subjects. For instance, Trelease and Paulino (1920) employed pure chemical salts and their studies referred mostly to the comparison of the nutritive merits for rice of various nitrogenous salts. Borja and Torres (1930) reported that the application of ammonium sulfate at the rate of 150 kgm. per hectare increased the yield of rice 20 per cent. From the 200 kgm.

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[1] Experiment Station contribution No. 1254. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

per hectare application, they obtained an increased yield of 40 per cent over the control, or unfertilized plants.

In Hawaii, Kelley (1914) found that at the rate of 300 lbs. per acre (or 340.8 kgm. per hectare) ammonium sulfate was most beneficial to rice. In the Philippines, Macasaet (1936) found that the N-P_2O_5-K_2O ratio best suited for upland rice when grown on tuff soil was, in grams, approximately 28-90-95. He also found that while ammonium sulfate was most beneficial to the plant when used alone, the addition of superphosphate to this fertilizer in tuff soil proved either harmful or less beneficial to the rice plant. In China, Chan (1929) reported that the best fertilizer mixture he had obtained was one that contained 120 lbs. of ammonium sulfate, 180 lbs. of superphosphate, and 60 lbs. of potassium sulfate per acre, equivalent to 136.4 kgm. of sulfate of ammonia, 204.5 kgm. of superphosphate, and 68 kgm. of sulfate of potash per hectare.

Objects of this study

This study was carried out with the objects of determining (*a*) the comparative nutritive values for rice of ammonium sulfate, single superphosphate, and potassium sulfate when used singly and in certain combinations; (*b*) the fertilizer needs of the rice plant; and (*c*) the nutritive deficiency of the soils, especially of Lipa clay loam, when grown to an upland rice.

Time and place of this study

The culture part of this study was carried out in the experimental yard of the Department of Agricultural Botany. Two series of cultures were tried. Both were run during the typical rice season in the Philippines, covering two separate periods, one from July 12, 1936, to November 5, 1936, and the other from June 20, 1937, to October 15, 1937.

MATERIALS AND METHODS

The plant

The plants used in this study were of an upland variety known as Carreon. The seeds were obtained from the Department of Agronomy. One day before planting, they were soaked in water for twenty-four hours. Four to six were planted in each pot. When the seedlings were about two centimeters high, they were thinned to two plants per pot.

The solid culture media

The soil. Two types of soils were used, namely, Lipa clay loam, and tuff (the subsoil of the Lipa clay loam). The Lipa clay loam was taken from a lot behind the Administration Building of the College of Agriculture. The tuff soil was obtained from the U. P. Rural High School reservation near Molawin Creek. These soils were separately pulverized, sieved, mixed thoroughly, and allowed to dry in the air. Samples were analyzed by the Department of Agricultural Chemistry. The Lipa clay loam was found to contain 0.13 per cent N, 0.20 per cent P_2O_5, and 0.37 per cent K_2O. The tuff soil contained 0.08 per cent N, 0.18 per cent P_2O_5, and 0.19 per cent K_2O.

Pots used. Two sizes of pots were used as containers. The smaller ones were glazed earthen pots each with a diameter of 21.5 cm. and containing 9 kgm. of air-dry soil. Seventy-eight pots of this type were used in the first series of cultures. The larger pots were ordinary empty gasoline tins. Ninety-six pots of this type were employed in the second series of cultures, each containing 19 kgm. of air-dry soil.

Fertilizers and fertilizer mixtures tried

Kind of fertilizers.[2] Ammonium sulfate containing 20.6 per cent N, single superphosphate with 18 to 20 per cent P_2O_5, and potassium sulfate with 48 to 50 per cent K_2O were used singly and in mixtures. The fertilizers were applied to the soil in the pots when the plants were about two centimeters high.

Single-fertilizer cultures. Each of the fertilizers mentioned above was added to the Lipa clay loam in four different amounts: 3.63 grams, or equivalent to 1 ton per hectare; 2.72 grams, or ¾ ton per hectare; 1.81 grams, or ½ ton per hectare; and 0.91 gram, or ¼ ton per hectare. These rates of application were also tried with the tuff soil. Control cultures in which no fertilizer was added were likewise tried. Each of these applications was tried on three similar cultures.

Fertilizer mixtures. The three fertilizers—ammonium sulfate, single superphosphate, and sulfate of potash, were mixed according to the triangular scheme devised by Schreiner and Skinner (1918).

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[2] The N, P_2O_5, or K_2O contents of these fertilizers were obtained from the data furnished by the Manila dealers.

The triangular diagram that was employed as a guide in mixing the fertilizers and the numbers of the different culture is shown in fig. 1.

The cultures are located at the intersections of lines. The row nearest the name of a fertilizer in fig. 1 received none of that fertilizer. The cultures in the second row, however, each received the fertilizer at the rate of ¼ ton per hectare, or 1.4 grams; those in the third row, ½ ton per hectare, or 2.8 grams; those in the fourth row, ¾ ton per hectare, or 4.2 grams; and those in the fifth row (the angle), 1 ton per hectare, or 5.6 grams. All the cultures (except the control) received the same total amount of fertilizer or fertilizer mixtures. The highest amount was 5.6 grams, or at the rate of 1 ton per hectare. Each culture was tried in triplicate.

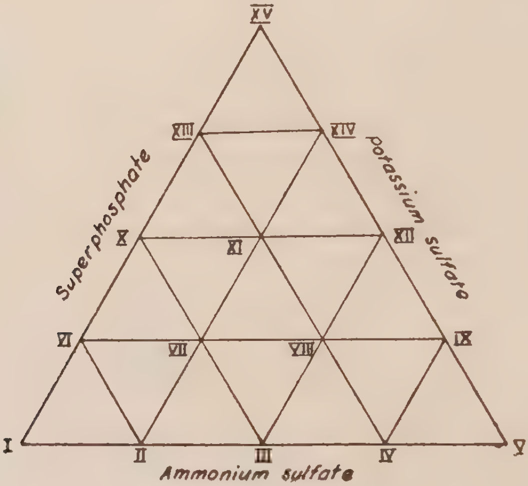

Fig. 1.—The distribution of the cultures

EXPERIMENTS AND RESULTS

Culture series

Two series of cultures were tried, each of which consisted of two sets of cultures, one for Lipa clay loam and another for the tuff soil. The two series of cultures are here designated as (*a*) single-fertilizer and (*b*) mixed-fertilizer.

Single-fertilizer series. The cultures in this series were started on July 12, 1936, and the plants were harvested on November 5, 1936. At the age of 50 days, the plants were photographed. Those that were grown in Lipa clay loam are shown in the upper row in fig. 2, whereas those grown in tuff soil are shown in the upper row of fig. 3. These same cultures were again photographed at the time of harvest (see fig. 2 and 3). Then the plants were harvested and the experimental data were gathered as directed or described under *Criteria of results.* The experimental data[3], including those on growth increments, as averages of triplicate cultures, are recorded in tables 1 and 2 for Lipa clay loam, and in tables 5 and 6 for tuff soil.

Mixed-fertilizer series. Two sets of cultures were tried, each consisting of 16 triplicate treatments. In one set, Lipa clay loam was employed as the solid medium, and in the other tuff soil was used. All these cultures were started on June 20, 1937, and the plants grown in them were harvested on October 15, 1937. At maturity, the plants were harvested and experimental data[4] were gathered as described under *Criteria of results.* Only the averages of the triplicate cultures are shown in table 4 for Lipa clay loam, and in table 8 for tuff soil. The data[5] on growth increments, as averages, are given in tables 3 and 7 for the plants that were grown in Lipa clay loam and those in tuff soil, respectively.

Care of the cultures

The cultures were directly exposed to the sun in the experimental yard at the rear of the Department of Agricultural Botany. Whenever necessary, they were watered, cultivated, and weeded. Any destructive insects found were immediately destroyed. During the booting stage, to prevent lodging, the plants in each culture were supported by means of a bamboo stake.

Criteria of results

Growth increment. At ten-day intervals the plants in each culture were measured from a known base mark near the surface of the soil in each pot to the tip of the tallest leaf. Measurements were started at the end of the first ten days and were continued at ten-day intervals until the plants had reached the booting stage. The data thus obtained from the triplicate cultures were averaged.

Height of plants. At the time of harvest, the height of the plants in each culture was measured from the base mark to the tip of the tallest leaf.

[3, 4, 5] The mass of original experimental data is on file in the Department of Agricultural Botany.

Length of roots. After harvesting the tops from each culture, the roots were gathered and the soil washed off with water. The data under this criterion were obtained by measuring the roots from the point of connection with the stem to the tip of the longest root.

Number of culms. The culms in each culture were counted. Both the bearing and non-bearing culms were included.

Number of panicles. The panicles in each culture were harvested and counted.

Air-dry weight of tops. After the panicles had been harvested, the tops (culms and leaves) were cut close to the roots. They were bundled, wrapped in paper, and labelled. The tops were dried in the oven at 90°C., and when dry, allowed to cool in the laboratory, and then weighed separately on a triple beam balance.

Air-dry weight of roots. The clean roots from each culture were dried in a manner similar to that of the tops.

Dry weight of panicles. The panicles that were obtained from each culture were placed in a bag, labelled, and then dried in the same way as the roots.

Air-dry weight of tops and roots. The weights of the air-dry tops and roots from each culture were added together. Then the weights of air-dry tops and roots from the triplicate cultures were averaged.

Climatic conditions

To give a general idea of the climatic or weather that prevailed during the experimental part of this study, table A is given.

TABLE A

MONTH	WIND VELOCITY		RELATIVE HUMIDITY			RAINFALL	TEMPERATURE	
	Day	Night	6:00 A. M.	2:00 P. M.	6:00 P. M.		Min.	Max.
1936	*miles*	*miles*	*per cent*	*per cent*	*per cent*	*mm.*	*°C.*	*°C.*
July	59.8	40.4	77.1	63.1	66.1	229.9	24.1	32.5
August ..	52.4	37.0	80.2	63.5	67.2	191.3	24.0	32.3
September	44.9	31.7	78.1	62.0	66.1	341.1	23.8	31.4
October .	60.7	45.4	81.0	60.9	71.3	200.7	24.1	30.5
November	62.7	33.3	80.8	62.8	71.3	269.4	23.3	28.8
1937								
June	61.1	32.6	81.4	52.1	65.8	114.7	24.0	33.8
July	72.5	51.1	78.9	62.9	72.8	225.4	23.8	32.6
August ..	63.4	37.8	82.1	64.5	71.8	386.7	23.5	31.5
September	50.4	32.6	80.7	64.2	68.8	287.5	23.4	31.2
October .	64.9	39.2	81.4	60.6	71.1	448.5	22.8	30.5

No attempt is made here to correlate the experimental data with the data on weather.

DISCUSSION OF RESULTS

The experimental data on hand have been studied to determine (*a*) how growth increments might indicate effects of fertilizers, (*b*) comparative effects of single fertilizers, (*c*) comparative effects of mixed fertilizers, and (*d*) the N-P_2O_5-K_2O contents of the best cultures. It is probably needless to point out in detail the comparative effects on color and width of the leaves of the rice plants when supplied with ammonium sulfate, single superphosphate, or potassium sulfate. It might be sufficient to say that of the three single fertilizers tried, only ammonium sulfate was found capable of producing dark green and relatively wide leaves of the rice plants (see upper rows in fig. 2 and 3).

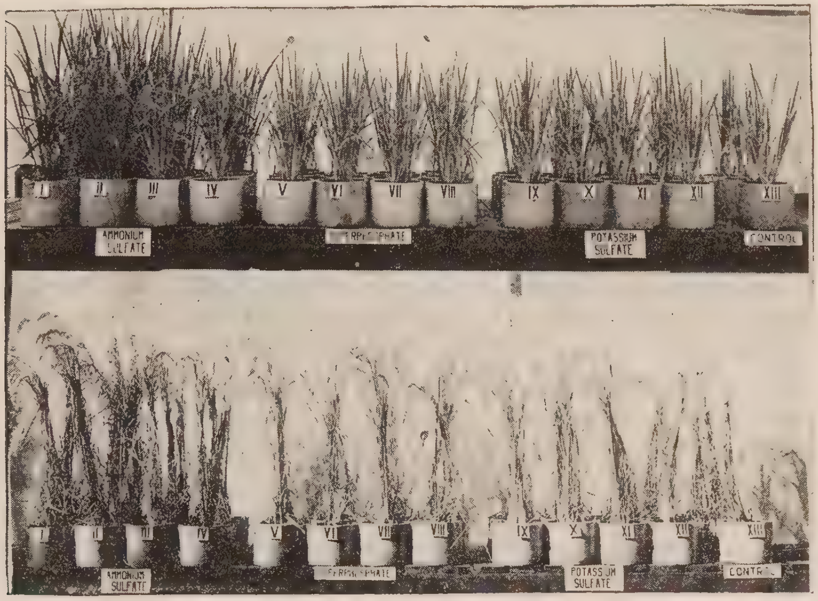

Fig. 2.—Rice plants (upper row 50 days and lower row the same number of plants 112 days old) grown in Lipa clay loam supplied with varying amounts of ammonium sulfate, superphosphate, or potassium sulfate. Cultures I, II, III, and IV with ammonium sulfate; V, VI, VII, and VIII with superphosphate; IX, X, XI, and XII with potassium sulfate; XIII, control—no fertilizer. (See table 2 for exact amounts of fertilizers used.)

Growth increments indicating effects of fertilizers

Examination of the data in tables 1, 3, 5, and 7 reveals the fact that, as a general rule, the fastest growth of the plants that were supplied with single fertilizers occurred during the first ten days. In the case, however, of the cultures that were supplied with the mixed fertilizers, the greatest growth increments appeared, also in a general way, during the first twenty days from the time of planting (refer to tables 3 and 7). Hence, the growth rates of the plants in the single fertilizer cultures slackened considerably, but they picked up again, although only slightly, during the 60-70 day period when the last growth measurement was made in this study. Such results, however, were not always obtained from the cultures that were supplied with the mixed fertilizers.

In order to determine the cultures that had the relatively fast growing plants and those that had the slow growing plants, the three highest values and the three lowest values under each 10-day interval in tables 1 and 5 (for the single fertilizers) were arbitrarily selected and indicated by H's and L's, respectively. The results show that most of the H's appear in those cultures that were supplied with ammonium sulfate fertilizer. On the other hand, the L's are scattered in cultures that were supplied either with the superphosphate or potassium sulfate, and in the unfertilized cultures. As expected, some of the growth increments obtained from the cultures that received the largest number of L's in the superphosphate or potassium sulfate-treated plants were even smaller than the corresponding growth increments for the control plants. Thus, it appears that the addition of superphosphate and potassium sulfate to Lipa clay loam or tuff soil deficient in N resulted in a decreased growth of the rice plants.

In the case of the ammonium sulfate fertilized cultures, however, especially those that received this fertilizer at the rates ranging from ½ to 1 ton per hectare (see cultures I, II, and III in tables 1 and 5), the rates of growth of the fertilized plants were always, or only with two exceptions, faster than those in the unfertilized cultures. In other words, addition of ammonium sulfate or of N to Lipa clay loam or tuff soil produced decidedly more steadily growing plants than those from the control.

We now turn attention to the growth increments at 10-day intervals shown in tables 3 and 7. Again the three highest values and the three lowest under each 10-day growth period were arbitrarily selected and indicated respectively by H's and L's in the tables.

The results show that, with the exception of three growth increments, (and these were obtained during the first ten days of growth when the plants were apparently not yet getting the full effects of the fertilizers), all the H's are found in the cultures that received ammonium sulfate. This fertilizer was either alone or mixed with superphosphate or potassium sulfate or mixed with both of these fertilizers. On the other hand, most of the L's are found in the control cultures and in cultures that received superphosphate or potassium sulfate alone or mixtures of these two fertilizers. In tables 3 and 7 are shown again the fact that while the growth increments of the plants that received ammonium sulfate were almost always greater than the corresponding growth increments of the plants that received no fertilizer at all, some of the growth increments of the plants from control cultures were even greater, although only slightly, than those that were fertilized either with superphosphate or potassium sulfate, or with mixtures of these two. For these reasons, it may be pointed out that the addition of ammonium sulfate alone or mixed either with superphosphate or potassium sulfate or mixed with both fertilizers to Lipa clay loam or tuff soil was sufficient to produce decidedly more thrifty-growing upland rice plants than those that were grown in the unfertilized cultures. But the addition of superphosphate or potassium sulfate, or of both fertilizers to Lipa clay loam or tuff soil was not conducive to a more vigorous growth of the plant.

Comparative effects of single fertilizers

The illustrations in fig. 2 and 3 clearly show that the most thrifty rice plants were obtained from cultures that were supplied with certain amounts of ammonium sulfate. This result was markedly noticeable when the plants were 50 days of age, especially when grown in tuff soil. The pictures also show that the plants that were fertilized either with superphosphate or potassium sulfate and the unfertilized ones were about equally poor in development. Thus, from illustrations alone a rough judgment of the comparative merits of the culture media tried is possible.

Other experimental data, however, are available (see tables 2 and 5) to study more carefully the comparative merits of the different cultures. To effect this comparison, it was necessary to select a few of the good and poor cultures. The two best results under each criterion were arbitrarily selected and indicated in tables 2 and 5 by H's. Similarly, the two lowest values under each criterion were indicated in the same tables by L's. The largest number of H's fall in cultures I and II in both tables. These two cultures may, therefore, be considered as the best in the lots. The L's, however, are scattered among the cultures that received either the superphosphate or the potassium sulfate. And coupled with the comparative stand of the plants shown in fig. 2 and 3, it may be safely concluded that none of the cultures that received an additional supply of superphosphate or potassium sulfate showed beneficial results. In fact, as shown in tables 2 and 5, the cultures so fertilized were not any better than the control.

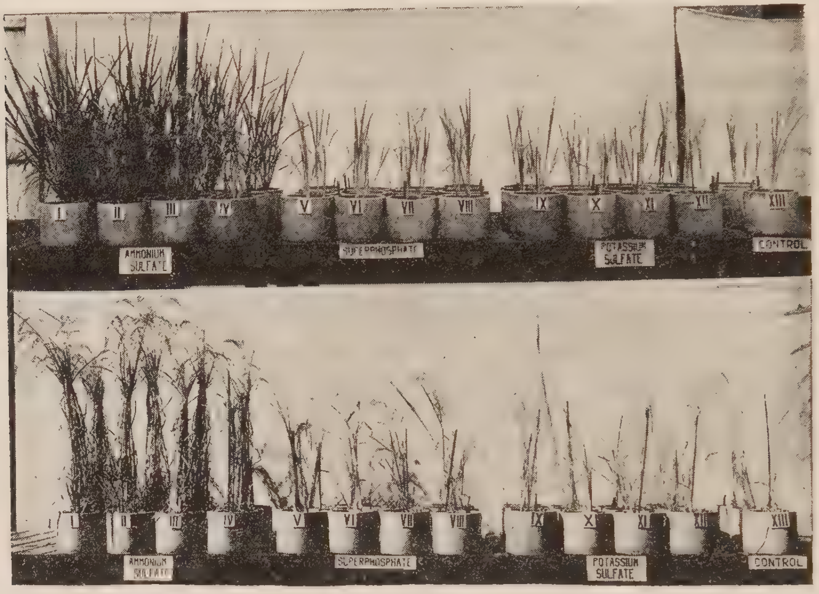

Fig. 3.—Rice plants (upper row 50 days and lower row the same plants 112 days old) grown in tuff soil supplied with varying amounts of ammonium sulfate, superphosphate, or potassium sulfate. Cultures I, II, III, and IV with ammonium sulfate; V, VI, VII, and VIII with superphosphate; IX, X, XI, and XII with potassium sulfate; XIII, control—no fertilizer. (See table 6 for exact amounts of fertilizers used.)

A comparison of the data on air-dry weight from cultures I and II with those from the control culture is shown in table B. Here the results under each criterion were arbitrarily considered as 100 and the other data under the same criterion were converted into relative values.

TABLE B

CULTURE NO.	AMMONIUM SULFATE		AIR-DRY WEIGHT OF			
	Rate of application	Amount used	Top	Root	Panicle	Top and root
Clay loam	*ton/ha.*	*grams*				
I	1	3.63	346	236	222	318
II	¾	2.72	328	167	198	287
XIII	0 (control)	0	100	100	100	100
			(18.7 gm.)	(6.3 gm.)	(12.7 gm.)	(25.0 gm.)
Tuff soil						
I	1	3.63	2120	2080	2323	2180
II	¾	2.72	1481	1500	1468	1532
XIII	0 (control)	0	100	100	100	100
			(2.7 gm.)	(0.5 gm.)	(1.3 gm.)	(3.1 gm.)

The data in table B, show that in both types of soil, culture 1 was the best. It was better than the control by 346 per cent in terms of the air-dry weight of the tops, and by 222 per cent in terms of the air-dry weight of the panicles. In tuff soil, however, the differences between cultures I and XIII were even greater, ranging from 2,323 per cent in terms of yield of panicle, and 2,080 per cent in dry weight of the roots—all in favor of culture I. In terms of the average, the application of ammonium sulfate to Lipa clay loam for upland rice, variety Carreon, at the rate of 1 ton per hectare, gave results 255 per cent better than those from the control. A similar application of the same fertilizer to tuff soil gave results 2,176 per cent better than those from the unfertilized culture. But the best results were obtained from the culture that received the largest amount of ammonium sulfate tried. For this reason, it might be possible to improve further on the results that have been obtained. Evidently this would be the case, as Almeda (1937) reported that his best culture on Lipa clay loam received ammonium sulfate at the rate of 1½ tons per hectare.

Comparative effects of mixed fertilizers

Examination of the data in tables 4 and 8 show that marked differences of results were obtained from certain types of cultures. Most of the high values seem to segregate to the lower portion of the tables, whereas the low values, to the upper portion of the tables. Of course, culture XVI, the control, had also decidedly low yields under the different criteria employed.

By arbitrarily selecting the three highest and the three lowest yields under each criterion and indicating these in tables 4 and 8, respectively, by H's and L's, interesting results were obtained. As may be seen in table 4, most of the H's fall in cultures XIII, XIV, and XV. In table 8, most of the H's fall in cultures XIV and XV. If these fertilized cultures were to be compared with the respective controls, in terms of air-dry weights, the data will be as relative values in table C.

TABLE C

CULTURE NO.	FERTILIZERS USED			AIR-DRY WEIGHT OF			
	Ammonium sulfate	Superphosphate	Potassium sulfate	Tops	Roots	Panicles	Tops and roots
Clay loam	*grams*	*grams*	*grams*				
XIII	4.2	0	1.4	436	408	264	431
XIV	4.2	1.4	0	426	480	289	434
XV	5.6	0	0	551	577	384	520
XVI	0 (control)	0	0	100	100	100	100
				(23.3 gm.)	(4.2 gm.)	(17.4 gm.)	(27.5 gm.)
Tuff soil							
XIV	4.2	1.4	0	1552	516	470	1196
XV	5.6	0	0	1636	520	653	1254
XVI	0 (control)	0	0	100	100	100	100
				(5.6 gm.)	(2.9 gm.)	(6.3 gm.)	(8.5 gm.)

In table C and in tables 4 and 8, culture XIV appears to be the best among those that were supplied with the fertilizer mixtures. This is true of Lipa clay loam as well as of tuff. This culture received 4.2 grams of ammonium sulfate and 1.4 grams of superphosphate. When compared with culture XV, however, culture XIV fell short in merit. For under all the criteria of results employed, culture XV was better than culture XIV; the difference was 403 per cent in Lipa clay loam, and 331 per cent in tuff soil. Culture XV received 5.6 grams of ammonium sulfate fertilizer, or at the rate of 1 ton per hectare. These two cultures differed from each other in two respects—in the amount of the nitrogenous fertilizer used and by the addition of potassium sulfate in one and not in the other. To make a more logical comparison in nutritive value, the amount of ammonium sulfate in culture XIV should be increased to 5.6 grams per pot, or at the rate of 1 ton per hectare. This comparison might be made later. For the present, however, it is safe to conclude that for upland rice, variety Carreon, when grown in Lipa clay loam, an application of ammonium sulfate fertilizer at the rate of 1 ton per hectare gave better results than a similar culture supplied with a mixture of ammonium sulfate at the rate of ¾ ton per hectare and single superphosphate at the rate of ¼ ton per hectare. Of all the cultures that had been supplied with mixed fertilizers, the latter gave the best results.

The results on yields of tops and roots and those on the weights of panicles from the different cultures may also be compared in graphical forms, as shown in fig. 4.

In this figure, the regions of the good cultures are shaded with criss-cross lines and the areas for the poor cultures, with parallel lines. It will thus be seen that the good cultures are found at the apex and near the apex of the two triangles. On the other hand, the poor cultures seem to congregate at the base of the triangle. For these reasons, it may be said that the good cultures were characterized by relatively high contents of ammonium sulfate alone or this with low contents of superphosphate or/ and potassium sulfate. The poor cultures, however, were characterized always by relatively low contents of ammonium sulfate alone or mixed with superphosphate or/ and potassium sulfate fertilizers, irrespective of the amounts present in the cultures.

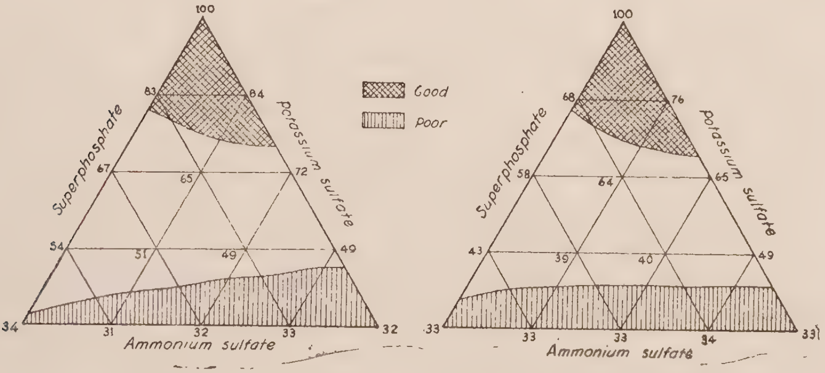

Fig. 4.—Relative values of yields of tops and roots (left) and of panicles (right) of rice plants grown in Lipa clay loam with different fertilizers and fertilizer mixtures.

The N-P_2O_5-K_2O contents of the best cultures

From the foregoing discussion, it has become apparent that the best results, under the criteria employed, were obtained from culture I (table 2, Lipa clay loam), culture I (table 6, tuff soil), cultures XIV and XV (table 4, Lipa clay loam), and cultures XIV and XV (table 8, tuff soil). But cultures I and XV received only ammonium sulfate, both at the rate of 1 ton per hectare, although in two different sizes of pots. Therefore, for the present, it might be possible to eliminate from further study culture I and consider only culture XV as this one was conducted in bigger pots. The selected good cultures are in table D.

TABLE D

CULTURE NO.	KIND OF SOIL	KIND OF FERTILIZER	RATE OF APPLICATION	
			Per pot	Per hectare
			grams	*ton*
XIV-a	Clay loam	Ammonium sulfate	4.2	¾
		Superphosphate	1.4	¼
XIV-b	Tuff soil	Ammonium sulfate	4.2	¾
		Superphosphate	1.4	¼
XV-a	Clay loam	Ammonium sulfate	5.6	1
XV-b	Tuff soil	Ammonium sulfate	5.6	1

To the 19 kgm. of the air-dry Lipa clay loam in culture XIVa, a mixture of 4.2 gm. of ammonium sulfate and 1.4 gm. of superphosphate was added. The N and P_2O_5 contents of the soil were, therefore, increased by the addition of these two fertilizers. On the other hand, the K_2O content remained the same as this culture received no potash-carrying fertilizer at all. Since the percentage contents of N, P_2O_5, and K_2O of the Lipa clay loam are known and the percentage of N in ammonium sulfate and that of P_2O_5 in superphosphate (see page 473), are also known, it was possible to estimate the N-P_2O_5-K_2O contents of culture XIVa. Evidently, when the estimate was made, this culture was found to contain 25.57 gm. of N, 38.27 gm. of P_2O_5, and 70.3 gm. of K_2O.

Similar estimates were made of the N-P_2O_5-K_2O contents of cultures XIVb, XVa, and XVb in table D. The results showed that culture XIVb, in which the rice plants were grown in tuff soil supplied with 4.2 gm. of ammonium sulfate and 1.4 gm. of superphosphate, contained 17.07 gm. of N, 34.27 gm. of P_2O_5, and 36.1 gm. of K_2O. Culture XVa (Lipa clay loam), which received only 5.6 gm. of ammonium sulfate, contained 25.85 gm. of N, 38.0 gm. of P_2O_5, and 70.3 gm. of K_2O, whereas culture XVb (tuff soil), to which only 5.6 gm. of ammonium sulfate was added, contained 17.36 gm. of N, 34.2 gm. of P_2O_5, and 36.1 gm. of K_2O.

The cultures in tuff soil were inferior to the corresponding cultures in Lipa clay loam. Therefore, the two best cultures that were found in Lipa clay loam (cultures XIV and XV in table 4, corresponding respectively to cultures XIVa and XVa in table D) contained 25.57 gm. of N, 38.27 gm. of P_2O_5, and 70.3 gm. of K_2O in one and 25.85 gm. of N, 38.0 gm. of P_2O_5, and 70.3 gm. of K_2O in the other. Of these two cultures, the one that had more N was the better.

SUMMARY AND CONCLUSIONS

1. It appears that the addition of P_2O_5 as superphosphate and K_2O as potassium sulfate to Lipa clay loam or tuff soil deficient in N resulted in decreased growth of the rice plants.
2. The addition of ammonium sulfate, or N, to Lipa clay loam or tuff soil produced decidedly much more thrifty-growing plants than those from the control cultures.
3. The addition of ammonium sulfate alone or mixed with either superphosphate or potassium sulfate or with both fertilizers to Lipa clay loam or tuff soil was sufficient to produce more thrifty-growing upland rice plants than those that were grown in the unfertilized cultures.
4. In terms of the average, the application of ammonium sulfate to Lipa clay loam for upland rice variety Carreon at the rate of 1 ton per hectare gave results 255 per cent better than those from the control. A similar application of the same fertilizer to tuff soil gave results 2,176 per cent better than those from the unfertilized culture.
5. It is safe to conclude that for upland rice variety Carreon grown in Lipa clay loam, an application of ammonium sulfate at the rate of 1 ton per hectare gave better results than a similar culture supplied with a mixture of ammonium sulfate at the rate of ¾ ton per hectare and single superphosphate at the rate of ¼ ton per hectare. Of all the cultures that had been supplied with mixed fertilizers, the latter culture gave the best results.
6. The good cultures were characterized by relatively high content of ammonium sulfate alone or this with low content of superphosphate or/and potassium sulfate. The poor cultures, however, were characterized always by relatively low content of ammonium sulfate alone or mixed with superphosphate or/and potassium sulfate fertilizers, irrespective of the amounts present in the cultures.
7. The two best cultures contained 25.57 gm. of N, 38.27 gm. of P_2O_5, and 70.3 gm. of K_2O in one, and 25.85 gm. of N, 38.0 gm. of P_2O_5, and 70.3 gm. of K_2O in the other. Of these two, the one that had more N was the better.

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TABLE 1

Average growth increments at 10-day intervals of rice plants grown in Lipa clay loam with varying amounts of ammonium sulfate, superphosphate, or potassium sulfate

(EXPERIMENT FROM JULY 12, 1936, TO NOVEMBER 5, 1936)

CULTURE NO.	AMOUNT OF FERTILIZER USED	GROWTH INCREMENTS AT 10-DAY INTERVALS						
		1-10	10-20	20-30	30-40	40-50	50-60	60-70
	grams	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
	Ammonium sulfate							
I	3.63	32.8H	15.5H	19.0H	5.1	8.6H	10.1H	14.9H
II	2.72	30.8	16.9H	16.9H	9.1H	9.3H	8.3H	15.2H
III	1.81	33.5H	14.8H	16.9H	6.1	6.5H	10.7H	10.7
IV	0.91	33.3H	14.0	13.6	4.5L	4.7	5.4	14.7H
	Superphosphate							
V	3.63	31.1	11.9	13.7	6.7H	3.7L	5.4	8.8L
VI	2.72	26.5L	12.3	12.4	6.3	3.9	5.1L	11.7
VII	1.81	29.0	7.5L	14.6	6.7	1.8L	6.6	10.0L
VIII	0.91	29.0	13.7	15.3	5.1L	3.6L	4.1L	14.4
	Potassium sulfate							
IX	3.63	29.4	10 5L	15.3	5.5	5.3	5.5	10.5
X	2.72	32.5	10 2L	10.6L	4.5L	5.9	7.1	8.2L
XI	1.81	31.0	11.2	11.3L	5.6	5.8	5.2	12.7
XII	0.91	20.0L	11.3	13.0	5.2	4.3	3.7L	12.3
XIII	Control	25.6L	13.9	8.5L	6.8H	5.7	6.9	10.5

TABLE 2

Average data obtained from rice plants (112 days old) grown in Lipa clay loam in pots with varying amounts of ammonium sulfate, superphosphate, or potassium sulfate

(EXPERIMENT FROM JULY 12, 1936, TO NOVEMBER 5, 1936)

CULTURE NO	FERTILIZER		HEIGHT OF PLANTS	LENGTH OF ROOT	CULMS	PANICLE	AIR-DRY WEIGHT			
	Rate of application	Amount used					Top	Root	Panicle	Top and root
	ton/ha.	*grams*	*cm.*	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
	Ammonium	sulfate								
I	1	3.63	114	65.7	22.3H	16.0H	64.7H	14.9H	28.3H	79.6H
II	¾	2.72	122H	64.5	16.0H	13.0H	61.3H	10.5H	25.1H	71.8H
III	½	1.81	117H	60.0	14.0	11.6	44.2	10.4	21.4	54.6
IV	¼	0.91	114	65.3	15.0	10.7	38.1	9.4	18.3	47.5
	Superphosphate									
V	1	3.63	107	55.8L	9.7	8.4	21.8	6.4	13.7L	28.3
VI	¾	2.72	109	70.3H	10.7	8.7	22.6	6.9	14.5	33.5
VII	½	1.81	107	59.3	9.7	9.0	24.7	7.3	17.6	32.0
VIII	¼	0.91	106	65.9H	8.7L	8.0L	21.5	5.1L	15.9	26.6
	Potassium	sulfate								
IX	1	3.63	106	56.7L	9.0	8.0L	21.6	6.1	14.7	27.6
X	¾	2.72	108	61.6	12.0	8.0L	21.2	4.9L	14.9	26.1L
XI	½	1.81	107	60.3	9.7	9.0	22.6	5.4	15.1	28.0
XII	¼	0.91	105L	61.1	8.7L	8.0L	20.6L	6.5	15.2	27.2
XIII	Control		102L	58.7	8.6L	7.4L	18.7L	6.3	12.7L	25.0L

TABLE 3

Average growth increments at 10-day intervals of rice plants grown in Lipa clay loam supplied singly or in combination with ammonium sulfate, superphosphate, or potassium sulfate fertilizers

(EXPERIMENT FROM JUNE 20, 1937, TO OCTOBER 15, 1937)

CULTURE NO.	SINGLE FERTILIZER AND FERTILIZER MIXTURES USED			GROWTH INCREMENTS AT 10-DAY INTERVALS							
	Ammonium sulfate	Super-phosphate	Potassium sulfate	1-10	10-20	20-30	30-40	40-50	50 60	60-70	70-80
	grams	*grams*	*grams*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
I	—	—	5.6	24.2	21.2L	5.4L	8.7	6.8L	8.4L	9.4L	7.6
II	—	1.4	4.2	24.9H	20.9L	5.6	5.3L	8.9	12.9	12.4L	6.2L
III	—	2.8	2.8	24.7H	23.2	6.6	5.6L	5.7L	10.9L	14.5	7.2L
IV	—	4.2	1.4	22.4	23.8	5.3L	8.0	4.1L	9.2L	12.5	10.4
V	—	5.6	—	21.4L	22.9	7.1	6.8L	7.2	12.6	16.6	10.5
VI	1.4	—	4.2	22.4	24.4	10.5	10.5	10.3	9.0	13.3	9.5
VII	1.4	1.4	2.8	24.2H	25.7H	9.8	8.9	9.5	14.5	16.6	8.8
VIII	1.4	2.8	1.4	21.5L	30.0H	9.8	7.0	6.9	14.0	20.8	7.4
IX	1.4	4.2	—	21.6	24.5	12.3H	7.5	12.1	17.2	16.4	13.4H
X	2.8	—	2.8	23.2	24.6	8.5	17.1	14.6H	15.9	19.1	13.0H
XI	2.8	1.4	1.4	22.2	22.5	15.1H	18.5H	14.5	18.1	18.4	10.1
XII	2.8	2.8	—	22.6	27.1H	10.7	18.4H	12.0	18.2	20.9H	8.2
XIII	4.2	—	1.4	22.5	25.4	11.2	15.3	16.9H	21.3H	21.5H	10.6H
XIV	4.2	1.4	—	22.5	24.8	11.7	15.5	13.9	19.9H	20.1H	10.1
XV	5.6	—	—	21.5	22.8	12.1H	17.8H	17.3H	18.7H	19.1	7.1L
XVI		Control		16.0L	13.3L	4.9L	15.0	11.6	11.1	11.1L	8.2

TABLE 4

Average data obtained from mature rice plants (115 days old) grown in Lipa clay loam in pots supplied singly or in combination with ammonium sulfate, superphosphate, or potassium sulfate

(EXPERIMENT FROM JUNE 20, 1937, TO OCTOBER 15, 1937)

CULTURE NO.	SINGLE FERTILIZER AND FERTILIZER MIXTURES USED			HEIGHT OF PLANT	LENGTH OF ROOT	CULMS	PANICLES	AIR-DRY WEIGHT			
	Ammonium sulfate	Super-phosphate	Potassium sulfate					Top	Root	Panicles	Top and root
	grams	*grams*	*grams*	*cm.*	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
I	—	—	5.6	115.9L	55.9	13.0	10.0	38.8	10.2	22.1	49.0
II	—	1.4	1.2	126.7	49.2L	15.4	11.4	35.9L	8.0L	21.9L	43.9L
III	—	2.8	2.8	125.2L	54.1L	14.4	10.0	35.9L	9.8	21.6L	45.7L
IV	—	4.2	1.4	134.5	60.9	13.0L	8.7L	36.6	10.6	22.8	47.2
V	—	5.6	—	131.2	61.2	11.7L	7.4L	37.4	8.1L	22.2	45.5
VI	1.4	—	4.2	137.3	57.4	18.4	10.7	60.7	16.6	28.5	77.3
VII	1.4	1.4	2.8	138.1	57.6	22.7	10.7	57.5	15.1	25.8	72.6
VIII	1.4	2.8	1.4	140.8	63.7H	20.7	11.0	55.3	15.5	26.7	70.8
IX	1.4	4.2	—	138.9	54.8	20.0	12.0	56.1	14.0	32.5	70.1
X	2.8	—	2.8	145.2	56.2	25.0	14.0	78.7	16.8	38.9	95.5
XI	2.8	1.4	1.4	160.5	65.6H	23.4	13.4	79.2	14.2	42.9	93.4
XII	2.8	2.8	—	155.1	60.2	23.7	13.0	87.1	16.4	43.0	103.6
XIII	4.2	—	1.4	165.6H	62.6H	28.0H	13.7H	101.7H	17.2H	45.6H	118.9H
XIV	4.2	1.4	—	168.7H	61.1	29.7H	15.0H	99.4H	20.1H	50.3H	119.5H
XV	5.6	—	—	164.2H	61.3	31.4H	20.7H	119.1H	24.3H	66.8H	143.4H
XVI		Control		125.7L	48.0L	7.4L	5.7L	23.3L	4.2L	17.4L	27.5L

TABLE 5

Average growth increments at 10-day intervals of rice plant grown in tuff soil with varying amounts of ammonium sulfate, superphosphate or potassium sulfate

(EXPERIMENT FROM JULY 12, 1936, TO NOVEMBER 5, 1936)

CULTURE NO.	AMOUNT OF FERTILIZER USED	GROWTH INCREMENTS AT 10-DAY INTERVALS						
		1-10	10-20	20-30	30-40	40-50	50-60	60-70
	grams	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
	Ammonium sulfate							
I	3.63	25.5	11.6	20.1H	8.9H	25.4H	8.3H	7.0H
II	2.72	27.5H	13.2H	21.1H	7.8H	15.9H	9.0H	9.1H
III	1.81	27.2H	12.5H	20.0H	5.9	16.1H	7.3H	8.9H
IV	0.91	24.7	13.6H	16.8	7.7H	15.5	2.9	5.3
	Superphosphate							
V	3.63	25.0	8.3	7.3	5.8	2.9L	2.0L	5.7
VI	2.72	21.0L	7.0L	6.1	5.2	4.8	2.5	6.1
VII	1.81	22.2	9.8	7.3	3.8	3.7	2.9	4.6
VIII	0.91	26.5H	11.1	5.9L	3.3	5.4	3.6	5.3
	Potassium sulfate							
IX	3.63	21.8L	12.4	6.2	2.3L	3.9	4.9	4.4L
X	2.72	25.5	7.0L	4.6L	3.2L	2.8L	3.5	4.5
XI	1.81	21.8L	9.0	5.9L	3.4	4.3	1.3L	2.6L
XII	0.91	25.7	6.1L	6.9	4.3	2.9L	4.1	5.8
XIII	Control	22.2	7.9	6.6	2.6L	4.3	2.3L	3.6L

TABLE 6

Average data obtained from rice plants (112 days old) grown in tuff soil in pots with varying amounts of ammonium sulfate, superphosphate, or potassium sulfate fertilizers

(EXPERIMENT FROM JULY 12, 1936, TO NOVEMBER 5, 1936)

CULTURE NO.	FERTILIZER		HEIGHT OF PLANTS	LENGTH OF ROOT	CULMS	PANICLES	AIR-DRY WEIGHT			
	Rate of application	Amount used					Top	Root	Panicles	Top and root
	ton/ha.	*grams*	*cm.*	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
	Ammonium sulfate									
I	1	3.63	128.3H	58.2	20.7H	15.7H	57.2H	10.4H	30.2H	67.6H
II	¾	2.72	125.4H	55.6	14.7H	9.4H	40.0H	7.5H	19.1H	47.5H
III	½	1.81	114.3	59.5H	11.3	8.7	30.9	6.3	14.9	37.2
IV	¼	0.91	98.4	62.7H	7.4	5.4	15.3	2.7	6.3	18.0
	Superphosphate									
V	1	3.63	77.5	57.2	3.7	2.7	3.7	0.8	1.8	4.5
VI	¾	2.72	62.7L	44.0	2.7L	1.5L	2.1L	0.5L	1.9	2.5L
VII	½	1.81	74.7	42.4	2.4L	2.5	2.4L	0.5L	2.1	2.9L
VIII	¼	0.91	75.4	45.8	2.7	2.0	3.5	1.1	2.4	4.5
	Potassium sulfate									
IX	1	3.63	69.4	58.4	4.0	2.7	3.4	1.1	1.4	4.4
X	¾	2.72	58.8L	49.2	3.0	1.7L	2.5	0.7	0.8L	3.2
XI	½	1.81	54.6L	52.0	3.7	2.5	2.6	0.8	1.5	3.4
XII	¼	0.91	73.3	30.4L	3.0	2.0	2.9	0.7	2.3	3.6
XIII	Control		67.0	33.7L	3.7	2.6	2.7	0.5	1.3L	3.1

TABLE 7

Average growth increments at 10-day intervals of rice plants grown in tuff soil supplied singly or in combination with ammonium sulfate, superphosphate, or potassium sulfate fertilizers

(EXPERIMENT FROM JUNE 20, 1937, TO OCTOBER 15, 1937)

CULTURE NO.	SINGLE FERTILIZER AND FERTILIZER MIXTURES USED			GROWTH INCREMENTS AT 10-DAY INTERVALS							
	Ammonium sulfate	Super-phosphate	Potassium sulfate	1-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
	grams	*grams*	*grams*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
I	—	—	5.6	19.5	20.3L	8.0	5.6	6.4	4.0L	2.3L	6.5
II	—	—	5.6	19.5	20.3L	5.4L	5.7	5.3	3.4L	6.0	3.8L
III	—	2.8	2.8	21.5	23.9	7.4	3.2L	4.8L	2.8L	3.6L	6.6
IV	—	4.2	1.4	22.2H	24.6	5.6L	2.3L	5.2	4.2	3.1L	3.8L
V	—	5.6	—	21.4	23.0	5.2L	2.8L	6.2	8.4	5.9	5.4
VI	1.4	—	4.2	21.9	23.6	9.6	13.3	5.7	6.5	11.2	7.8
VII	1.4	1.4	2.8	22.1H	28.4H	12.2	5.7	5.1	5.9	10.2	7.2
VIII	1.4	2.8	1.4	22.0	27.9H	11.8	6.4	7.8	9.6	6.5	6.8
IX	1.4	4.2	—	22.4H	26.8	11.3	6.2	7.6	11.5	13.1H	5.9
X	2.8	—	2.8	19.6	22.9	11.5	11.4	11.8	13.5H	13.3H	5.9
XI	2.8	1.4	1.4	21.7	26.9	12.4H	17.6H	10.1	8.8	9.6	3.5L
XII	2.8	2.8	—	21.8	26.3	13.1H	12.1	4.7L	16.5H	12.1	11.8
XIII	4.2	—	1.4	19.4	20.7L	13.8H	22.1H	16.9H	19.7H	11.4	14.1H
XIV	4.2	1.4	—	20.0	28.5H	11.3	13.7	12.9H	10.9	16.3H	12.9H
XV	5.6	—	—	18.6L	22.3	9.9	19.4H	17.4H	12.7	12.7	14.2H
XVI	Control			18.3L	17.7L	7.0	6.7	3.2L	5.8	8.7	5.4

TABLE 8

Average data obtained from mature rice plants (115 days old) grown in tuff soil in pots supplied singly or in combination with ammonium sulfate, superphosphate, or potassium sulfate fertilizers

(EXPERIMENT FROM JUNE 20, 1937, TO OCTOBER 15, 1937)

CULTURE NO.	SINGLE FERTILIZER AND FERTILIZER MIXTURES USED			HEIGHT OF PLANT	LENGTH OF ROOT	CULMS	PANICLES	AIR-DRY WEIGHT			
	Ammonium sulfate	Super-phosphate	Potassium sulfate					Top	Root	Panicles	Top and root
	grams	*grams*	*grams*	*cm.*	*cm.*	*number*	*number*	*grams*	*grams*	*grams*	*grams*
I	—	—	5.6	99.5	58.0	9.6L	6.0	17.8L	4.8L	7.4	22.6L
II	—	1.4	4.3	94.8L	54.3	11.0	4.6L	17.6L	9.3	6.9	26.9
III	—	2.8	2.8	101.9	54.6	13.6	6.3	21.6	9.4	7.6	31.0
IV	—	4.2	1.4	99.1	63.4H	12.3	7.0	18.5	7.9L	6.3L	26.4
V	—	5.6	—	97.5L	56.1	11.0L	5.3L	17.9	8.2	6.8L	26.1L
VI	1.4	—	4.2	128.8	61.2H	19.6	9.0	44.1	11.9	21.5	56.0
VII	1.4	1.4	2.8	124.6	62.6H	24.0	9.6	53.7	13.3	16.9	67.0
VIII	1.4	2.8	1.4	119.7	61.1	22.6	9.0	46.7	13.6	16.8	60.3
IX	1.4	4.2	—	125.5	53.8	20.6	8.6	47.7	11.1	14.9	58.8
X	2.8	—	2.8	141.8	57.3	23.3	11.0	79.1H	14.4	34.5H	93.5H
XI	2.8	1.4	1.4	131.9	48.4L	23.3	11.6H	67.7	10.6	28.9	78.3
XII	2.8	2.8	—	135.2	48.6L	28.0H	13.0H	75.6	16.4H	28.9	92.0
XIII	4.2	—	1.4	154.2H	48.7	23.3	9.3	78.7	13.2	27.2	91.9
XIV	4.2	1.4	—	144.1H	52.3	28.0H	10.6	87.0H	14.9H	29.6H	101.9H
XV	5.6	—	—	157.7H	53.4	29.0H	15.0H	91.7H	15.1H	41.4H	106.8H
XVI		Control		94.3L	33.8L	7.3L	5.0L	5.6L	2.9L	6.3L	8.5L

VARIABILITY AMONG ANTHURIUM PLANTS PRODUCED FROM SEEDS [1]

VICENTE M. DAWIS
Of the Department of Agronomy

WITH FOUR TEXT FIGURES

Anthurium crystallinum Lind. and Andre., locally known as locaria, locrasia or anthurium is a foliage ornamental plant with large ovate-cordate, petioled, and deep velvety green leaves. The midrib and veins are crystal white bands. The green spathe is linear, oblong, and acuminate.

Anthurium is grown as a potted ornamental plant for window garden or for garden under shade. It is also grown as a source of cut-leaves for which there is sometimes a market. The leaves are used for decorating wreaths. A leaf of anthurium placed on a wreath raises the price of the latter by over fifty centavos or a peso.

The color and size of the midrib and veins have something to do with the value of the plant as an ornamental. A plant that has bright, crystal white, glossy, and large midrib and veins commands a better price than one that has dull and small midrib and veins.

The common way of propagating anthurium is by asexual means. The whole plant is cut off above the soil; the top is cut off below the leaves; and the rest of the stem made into cuttings of desired length, each containing one or more buds. The top cutting is the best part for planting because it grows faster than the stem cuttings. According to the writer's observation and experience, a seven year old plant can only give six cuttings. This is a very slow method of propagating this plant commercially. It would require very many plants to produce cuttings for commercial scale propagation. The anthurium plant also produces seeds which could be germinated with special care. A study of variation and selection of these seedlings may lead to the improvement of this ornamental plant.

Object

The object of this paper is to report the results of a study of variability observed among plants grown from seeds of *Anthurium*

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[1] Experiment Station contribution No. 1255. Read before the Los Baños Biological Club November 18, 1937.

crystallinum and of a comparison of the rate of multiplication by seeds and by cuttings of the same plant.

Time and place

This work was started on May 2, 1930, and it is still under way at present. This report, however, covers data obtained up to November 15, 1937.

The work was performed in the ornamental nursery of the Department of Agronomy, College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

The mother plant. The mother plant used in this study was already an old plant when the work was begun. It belonged to Doctor Valente Villegas who reported that it had been in his window garden and who brought it to the ornamental nursery in March, 1930, for asexual multiplication. Having only three leaves at that time, it was not made into cuttings but was allowed to produce seeds.

One anthurium plant of about the same size belonging to the College was asexually propagated at the same time as the private plant.

The flower spike. In the ornamental nursery, which was cool and shady, the plant from Doctor Villegas began to grow more vigorously than when in his window garden; one month after it was transferred, it produced three flower spikes. One of these flower spikes had both male and female flowers. The other two bore only male flowers.

The College anthurium plant had been producing male flower spikes only.

The fruits. About two-thirds from the base of the flower spike, that had both male and female flowers, some protuburances, scattered unevenly, were noticed. Upon ripening, these protuburances became red and proved to be fruits.

On May 2, 1930, eighteen of these fruits at the base of the spike were found ready to drop to the ground or be eaten by birds. The ones at the base ripened first. Almost every other day more ripened. There was no fruit found with less than one or more than two seeds. Sixteen of those that ripened first had two seeds each and two had one seed each giving a total of eighteen fruits with thirty-four seeds. On May 5, 1930, eleven fruits with two seeds and three fruits with one seed each ripened giving a total of fourteen fruits with twenty-five seeds. On May 7, 1930, ten fruits with two seeds and two fruits with one seed each ripened giving a total of twelve fruits with twenty-two seeds. On May 10, 1930, twenty fruits with two seeds and three fruits with one seed each ripened giving a total of twenty-three fruits with forty-three seeds. On May 13, 1930, only one fruit with two seeds and eight fruits with one seed each ripened giving a total of nine fruits with ten seeds.

The whole spike gave a total of seventy-six fruits with one hundred thirty-four seeds of which fifty-eight fruits had two seeds each and eighteen fruits had one seed each.

The seed. The seed was enclosed by a thin slimy substance which was surrounded by the red, thin membrane of the fruit. It had the size of half a mongo (*Phaseolus radiatus*) seed. The fruits were picked when ready to fall and the seeds were planted the same day after washing in water.

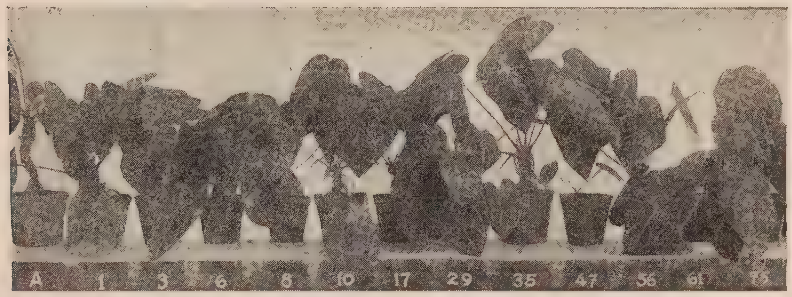

Fig. 1.—Anthurium seedlings 1, 3, 6, 8, 10, 17, 29, 35, 47, 56, 61, and 75, showing variability in height of plants and in size and shape of leaves. (*A*) to the left is the mother plant. Photograph by the Photographic Division, Department of Soils.

Method of germination. The seeds were planted as they ripened in a double pot with fine sand as the medium. The propagating pot was placed in a wardian case, which in turn was kept in a roofed nursery, receiving light but not direct sunshine. On May 28, 1930, the seeds began to germinate. When the seedlings had one leaf each they were transplanted. On June 19, 1930, eighty seedlings were transplanted in the smallest pots (No. 0) we had. On July 18, 1930, thirty-eight seedlings were transplanted, three on August 5, 1930, nine on August 27, 1930, and three on September 23, 1930, giving a total of one hundred thirty-three seedlings (fig. 1). No more seeds germinated after September 23, 1930.

Care of seedlings. The small seedlings were cared for under a nursery shed protected from rain. When the plants had produced two leaves each they were transplanted again into larger pots (No. 1). At the age of about two years, the seedlings were again transplanted into still larger pots. These seedlings after a week were transferred to a cool, shady, vine-covered nursery shed where the mother plant was being kept.

Propagation by cuttings. On May 2, 1930, the same day the first batch of seeds was planted, the College anthurium plant was propagated asexually. The terminal portion below the leaves was cut first and the stem was made into cuttings, each containing one to two buds. There were four cuttings made from the stem. All the stem cuttings were planted in a sand bed under shade. The top was planted in a pot with soil and was placed among other anthuriums. On July 27, 1930, the stem cuttings began to grow. Only one bud was allowed to develop. When two or three leaves had developed the rooted cuttings were potted with ordinary soil in a small pot. Pot No. 3 was used. These were then placed under a cool vine-covered nursery shed with the other plants.

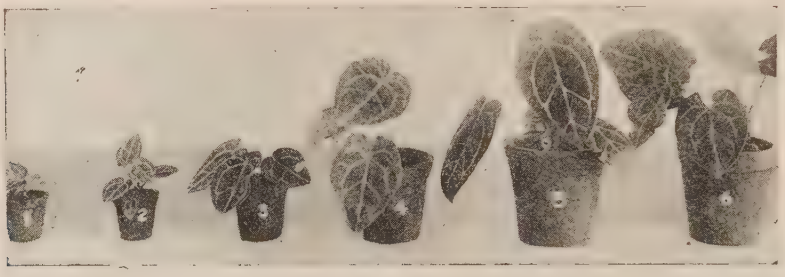

Fig. 2.—Anthurium seedlings at (*1*) one-half year, (*2*) one year, (*3*) two years, (*4*) three years, (*5*) three and one-half years, and (*6*) four years of age. Photograph by Photographic Division, Department of Soils.

CHARACTERS STUDIED

The two most important characters studied among seedling plants of anthurium are the length of stem and number of leaves. These characters give the plants their commercial value. Other characters as venation, color, size and shape of leaves as well as sinus or opening at the base of leaves were also studied. These characters also affect the ornamental value of anthurium.

RESULTS AND DISCUSSION

A fruit of anthurium may have only one or two seeds. The seeds used in this study gave 99.25 per cent germination.

It took from 26 to 116 days or about one to three months to germinate the seeds, under ordinary conditions. Although it took a long time to germinate the seeds the percentage of germination was very high.

After 28 days or about a month the seedlings could be transplanted.

As found in the subsequent plantings of seeds, results of which are not included in this paper, the seeds could also be germinated in pots or seed boxes with either soil or sand. Seedlings three or four years old and bearing three to four leaves were already in a salable stage (fig. 2). Some seedlings at this age which came from subsequent plantings were sold at ₱0.50 to ₱1.00 each depending upon the beauty of the plants.

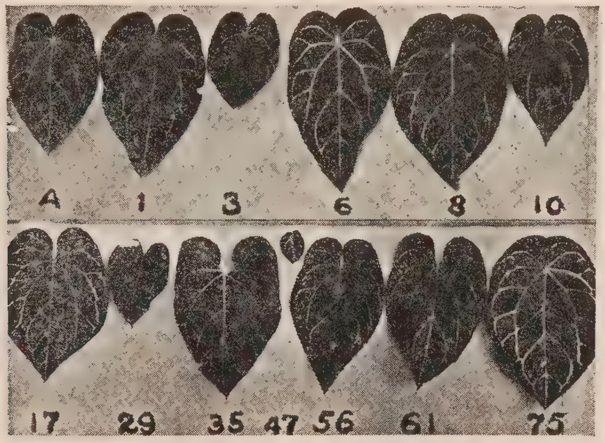

Fig. 3.—A leaf of the mother plant (*A*) and a leaf of each of the anthurium seedlings shown in figure 1 arranged in the same order to indicate differences in shape, size, and venation. Photograph by Photographic Division, Department of Soils.

At an early age, the anthurium seedlings hardly showed signs of variability. After five years, however, these plants grown from seeds showed distinct variability in size and shape of leaves and in height of plants as shown in figure 1. The leaves had an average breadth of 21 centimeters and length of 33 centimeters.

Some plants have large, pointed and heart-shaped leaves whereas others have smaller leaves of the same shape. Some have large almost rounded leaves, whereas others have small leaves of the same almost rounded shape (fig. 3).

Some plants have beautiful arrangements of veins, three or four veins on each side of the leaf branching from the leaf star or point of junction of the leaf and petiole, and the rest of the veins branching from the midrib, one opposite another. Other plants have a similar arrangement except that the rest of the veins branch from the midrib alternately.

Some plants have large, bright and crystal white midrib and veins; others have a dull color. Some plants are bright and glossy while others are a faded green.

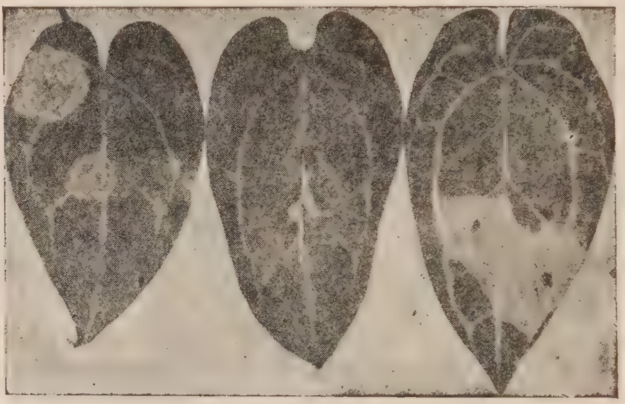

Fig. 4.—Leaves of anthurium seedlings attacked by anthracnose showing different stages of infection. Photograph by the Photographic Division, Department of Soils.

The average number of leaves is four and the range is from one to eight.

Some plants have a wide open sinus, others have the bases of leaves almost touching each other, and still others have the bases of the leaves overlapping.

Some have upright, some horizontal, and others drooping leaves.

Only two plants were left of the College anthurium propagated asexually. The plant from the top cutting and two other plants from the stem cuttings died. During the rainy season in 1935, many of the plants both from sexually and asexually propagated plants were infected with anthracnose (fig. 4). Mr. E. F. Roldan, of the Department of Plant Pathology, who studied the disease states that it is caused by *Gloeosporium anthurii* Allesch., a species probably identical with *G. thümenii* (v. Th.) Sacc. The result was that three of the plants produced asexually and fifty-four of those obtained from seeds died of anthracnose.

One of the two plants grown asexually has a stem 11.0 centimeters long and three leaves, and the other has a stem 14.8 centimeters long and three leaves also. These are below the average in number of leaves on plants grown from seeds. Both plants have drooping leaves of almost the same size, shape, and color.

Of the seedlings produced and studied, twelve very distinct varieties were selected, the selection being based upon the size and form of the leaves alone. There might be more varieties if the selection were to be based upon other characters.

Size and form of leaves were chosen as bases for the selection of varieties because, as has been pointed out already, these are the characters that give attraction to the plants and determine to a large extent their market prices.

The College anthurium produced only five plants, one from the top and four from the stem cuttings. Three of these plants including the top died of severe infection with anthracnose (Fig. 4). The two remaining plants being asexually propagated are similar to each other. Both have drooping leaves and are almost identical in the shape and size of leaves and height of plants.

SUMMARY AND CONCLUSION

1. A flower spike of *Anthurium crystallinum* with male and female flowers was found to produce one hundred thirty-four seeds. A plant may produce one or two flower spikes with male and female flowers a year.

2. It took from one to three months to germinate anthurium seeds.

3. Three years after germination the plants are in salable stage.

4. Anthurium grown from seeds showed distinct variability. New varieties were produced through seed propagation.

5. Asexual method of propagating anthurium is very slow. A seven and one-half year old plant may produce only five or six plants.

6. *Anthurium crystallinum* can be propagated much more rapidly by seeds than by cuttings.

A COMPARATIVE STUDY OF THE BEHAVIOR OF LOS BAÑOS CANTONESE, NAGOYA, AND SINGLE COMB WHITE LEGHORN PULLETS IN BATTERY LAYING CAGES [1]

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In an effort to control many of the known poultry diseases and parasites, the use of the "egg factory" system, or the confinement of layers in laying batteries, has become popular in the United States and England. The poultry industry of the Philippines, however, has not sufficiently attained that stage of intensification and confinement of commercial poultry to justify the immediate adoption of the aforementioned system. To keep pace with the modern trends of commercial egg farming, it is necessary to substantiate the merits attributed to the "egg factory" system. Of greater practical value would be the study of problems confronting the development of various phases of its application which may serve as determining factors in the use of laying batteries in the Philippines.

Review of literature

The preliminary investigations of Olivares (1937) on Los Baños Cantonese fowls is the only study pertaining to battery laying cages made in the College of Agriculture. To determine a suitable ration for use among caged layers, Olivares (1937) found that an all-mash ration consisting of 2 parts fish meal, 5 corn meal, 1 copra meal, and 2 rice bran by weight, or 2-5-1-2, for short, proved to be the best among other mixtures consisting of the same ingredients but in varying proportions. He further found that an amount of 2 per cent cod-liver oil in the 2-5-1-2 ration was sufficient to prevent leg weakness among the confined birds.

Gonzalez (1926) reported the failure of temperate breeds of chickens to adapt themselves to Philippine conditions. He also stated that those that survived were unthrifty, run-down, and susceptible to diseases. The popular Cantonese breed of fowls introduced into the Islands from China was reported by Fronda (1924) to respond favorably to local environmental conditions and to the native methods of feeding, care, and management. The Nagoya fowl introduced into the Islands from Japan in 1926 (Fronda and Gonzalez, 1929) was reported by Shinji (1927) to have come from a cross of native Japanese fowls and Shanghais from South China in the latter part of the nineteenth century. Fronda and Gonzalez (1929) stated that from the history of this breed it is highly probable that it possesses Cantonese blood. This may account for the breed being almost as at home in the Philippines as the Cantonese breed.

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[1] Experiment Station contribution No. 1256.

Studies by Martir (1933) on the economy of egg production of the Nagoya and the Los Baños Cantonese breeds of fowls showed that, on an average, the Los Baños Cantonese fowl laid more eggs at lower cost per dozen than the Nagoya fowl. He also reported that the Nagoya breed laid heavier eggs but registered higher mortality than the Los Baños Cantonese breed.

Object of the study

The object of the study was to determine the relative effects of caging in battery laying cages on the general behavior of Los Baños Cantonese, Nagoya, and Single Comb White Leghorn pullets.

Time and place of the work

The experiment was conducted in the poultry laboratory of the Department of Animal Husbandry from December 22, 1935, to December 21, 1936, a period of 366 days.

PLAN OF THE STUDY

A total of thirty-six pullets consisting of twelve each of Los Baños Cantonese, Nagoya, and Single Comb White Leghorn breeds were used in this study. All the pullets had laid their first egg before the experiment was started. They were confined in metal laying batteries manufactured by M. H. Arndt and Company of New Jersey, U. S. A., and its special features were described by Olivares (1937).

All of the birds were given the same basal mash ration reported by Olivares (1937) to be the most profitable in his battery laying experiment. This is composed of the following ingredients (parts by weight): 2 parts "Lighthouse" fish meal, 5 corn meal, 1 copra meal, and 2 rice bran. This ration was supplemented with 2 per cent cod-liver oil. Based on the chemical analysis of these feeds, the nutritive ration of this mixture was 1:2.74.

Green feed in the form of fresh chopped wild grasses, obtained in the vicinity of the laboratory, and grit consisting of a mixture of coarse lakeshore sand and powdered shells were given in unlimited amounts to the battery birds. The layers had free access to feed and water at all times. The supply of feed and water was renewed daily.

Records

Records of egg production were kept. All broken and abnormal eggs were accounted for. The initial and final weights of the birds were taken with the aid of a portable Fairbanks balance sensitive to 20 grams. The weekly and total feed consumption of the different lots were noted. Mortality was recorded. The feces voided by the birds were weighed periodically.

RESULTS AND DISCUSSION

Egg production. Table 1 shows a comparison of the egg production of the different groups of pullets. It may be seen in table 1 that the Nagoya pullets had the highest egg production, the Single Comb White Leghorn pullets were next, and the Los Baños Cantonese pullets were a close third.

It may be mentioned in this connection that cases of three eggs laid in two days were noticed a number of times in the Nagoya group. The texture of the shell of eggs produced in all the groups was noted to be somewhat thinner than normal. While a number of soft-shelled eggs were produced in all lots studied; many more of these were laid by the Single Comb White Leghorns than by either the Los Baños Cantonese or the Nagoya pullets.

Martir (1933) reported no significant difference between the egg production of Nagoya and Los Baños Cantonese kept in laying pens. On the other hand, in a report by Fronda (1933) on the Second Philippine Egg Laying Contest (1931-1932), it was found that the Nagoya fowls were better layers than the Los Baños Cantonese. In the same report, it was also revealed that the percentage of egg production of Single Comb White Leghorn pullets was slightly higher than that of the Nagoya pullets. This is contradictory to the results obtained in the present study.

Weight of the pullets. The average weights of the pullets at the start and at the end of the study are given in table 2. It may be seen that all lots gained in weight. These gains in weight may be considered normal for the birds were still growing when they were placed in the battery cages.

Mortality. It may be seen from the data presented in table 3 that although all lots sustained losses in mortality, only one Los Baños Cantonese pullet died out of the twelve birds in the lot. Both the Nagoya and the Single Comb White Leghorn groups suffered heavy mortality; five deaths were recorded in each breed. These figures show that the Los Baños Cantonese pullets are the most resistant for use in battery laying cages.

It should be noted here that while none of the birds in the battery laying cages died from leg-weakness, a few of the pullets in the Single Comb White Leghorn lot exhibited symptoms of this trouble as early as the fifth month of the experiment. This condition, however, did not seem to affect greatly the laying activity of the birds concerned. Also, a large number of soft-shelled eggs and eggs without shell were produced by the Single Comb White Leghorn pullets, suggesting very strongly that the two per cent cod-liver oil added to the ration was probably not sufficient to provide the necessary requirement of vitamin D. In the case of the Los Baños Cantonese and Nagoya pullets, the two per cent cod-liver oil in the ration proved adequate.

Cost of egg production. Based on the average current price of the feeds used in this study, a kilogram of the mash used (2 parts "Lighthouse" fish meal, 5 corn meal, 1 copra meal, and 2 rice bran) supplemented with one per cent common table salt and two per cent cod-liver oil, costs 7.04 centavos. A similar ration but without a supplement of cod-liver oil cost 5.89 centavos a kilogram. Thus, the battery laying ration supplemented with cod-liver oil costs only 1.15 centavos per kilogram more than the same mixture without the supplement. The cost of the powdered shell and green feed, both of which were furnished the birds, was not included as the cost of these items was negligible, and the value of the droppings voided more than compensated for their cost.

In table 4, it may be noted that of the three breeds compared, the Los Baños Cantonese pullets consumed the least feed. From these figures it was found that the Los Baños Cantonese pullets produced the most economical eggs. Although the Nagoya pullets consumed slightly more feed than the Single Comb White Leghorns, the cost of eggs per dozen was actually less because they produced relatively more eggs than the Single Comb White Leghorns.

If the returns from the sale of eggs above the cost of feed per bird are considered, the Nagoya pullets gave the highest return. This group was followed by the Los Baños Cantonese pullets, and the lowest was that of the Single Comb White Leghorns. The returns from the Single Comb White Leghorns was 43 centavos lower than that of the Nagoyas, and 30 centavos lower than that of the Los Baños Cantonese.

Efficiency of the different breeds. The relative efficiency of the three breeds based on the average egg production, mortality, and amount of feed consumed to produce a dozen eggs was determined. With the performance of the Los Baños Cantonese pullets being used as 100 per cent, the Nagoya pullets easily ranked second with 89.4 per cent. The Single Comb White Leghorn pullets were the least efficient, the average efficiency being 81.2 per cent. If the average efficiency is taken as the main criterion for the basis of comparison, it may be stated that, of the three breeds tried, the best to use in the batteries is the Los Baños Cantonese breed, and the poorest is the Single Comb White Leghorn.

Other observations. The birds in all the groups studied exhibited rather pale combs, and they developed overgrown toe nails. It was observed that the wire floor apparently did not make the feet of the birds sore, nor did it affect them in any way. The feces voided by all the birds were much more watery than those voided by birds kept outdoors. Weighed while fresh, the Los Baños Cantonese pullets were observed to produce 19.8 kilograms of feces a year, the Nagoyas, 27.6 kilograms, and the Single Comb White Leghorns, 26.2 kilograms. A week's accumulation of these feces in the dropping pans during the rainy months served as an excellent breeding place for houseflies.

SUMMARY AND CONCLUSIONS

1. Of the three breeds compared, the Nagoya pullets had the highest egg production, followed by the Single Comb White Leghorns and the Los Baños Cantonese.

2. All the breeds gained in weight. The Nagoya pullets made the most gain, and the Single Comb White Leghorns, the least.

3. The Los Baños Cantonese pullets registered the lowest mortality. Both the Nagoyas and the Single Comb White Leghorns had high mortality.

4. The Los Baños Cantonese pullets consumed the least feed, and the Nagoya pullets, the most.

5. The most economical eggs were produced by the Los Baños Cantonese pullets and the most expensive by the Single Comb White Leghorns.

6. Based on the average egg production, mortality, and amount of feed consumed to produce a dozen eggs, the most efficient of the three breeds was the Los Baños Cantonese, and the least efficient, the Single Comb White Leghorn.

7. Generally speaking, the addition of two per cent cod-liver oil in the ration was found to be sufficient. There were strong indications, however, that this amount may not be adequate for the Single Comb White Leghorns where some birds showed symptoms of leg weakness, and laid a large number of soft-shelled eggs.

8. Although the birds had rather pale combs and very much overgrown toe nails the confinement in the battery cages apparently did not have any harmful effects.

9. The Nagoya pullets produced the most feces and the Los Baños Cantonese, the least. The feces were watery.

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TABLE 1

Annual egg production

BREEDS	PERCENTAGE PRODUCTION	AVERAGE PRODUCTION	RELATIVE EFFICIENCY [a]
Los Baños Cantonese	33.9	124.1	100.0
Nagoya	40.4	147.3	119.0
Single Comb White Leghorn	35.9	131.5	106.0

[a] Based on Los Baños Cantonese as 100 per cent.

TABLE 2

Average weight of the pullets

BREEDS	AT THE START	AT THE END	GAIN
	kgm.	*kgm.*	*per cent*
Los Baños Cantonese	1.33	1.53	15.0
Nagoya	1.75	2.06	17.7
Single Comb White Leghorn	1.37	1.54	12.4

TABLE 3

Mortality of the pullets

BREEDS	NUMBER OF BIRDS		PERCENTAGE MORTALITY
	Start	End	
Los Baños Cantonese	12	11	8.4
Nagoya	12	7	41.7
Single Comb White Leghorn	12	7	41.7

TABLE 4

Cost of feed consumed and value of eggs produced

ITEMS	LOS BAÑOS CANTONESE	NAGOYA	SINGLE COMB WHITE LEGHORN
Average feed consumed	22.32 kgm.	30.35 kgm.	29.78 kgm.
Value of feed consumed [a]	₱ 1.57	₱ 2.14	₱ 2.10
Total eggs produced	1464	1348	1312
Value of eggs produced [b]	₱43.92	₱40.44	₱39.36
Feed to produce one dozen eggs	2.16 kgm.	2.47 kgm.	2.72 kgm.
Value of feed to produce one dozen eggs	₱ 0.15	₱ 0.17	₱ 0.19
Returns from sale of eggs above cost of feeds	₱ 2.15	₱ 2.28	₱ 1.85

[a] Feed cost was 7.04 centavos a kilogram.
[b] Value of eggs was ₱0.36 a dozen.

A MODIFIED FUMELESS NITROGEN DIGESTION APPARATUS[1]

LAURO A. YNALVEZ
Of the Department of Agricultural Chemistry

WITH ONE TEXT FIGURE

In the course of our digestion work for nitrogen determination the following objectionable features were observed in the Sy's Fumeless Apparatus:[2] (*a*) Part of the rubber from the rubber tubing connection of the manifold and the connecting tubes is dissolved by the acid fumes and washed down into the flasks by the condensed acid, thereby adding foreign material to the samples being digested. (*b*) As the lower bulb of the two-bulb connecting tubes fit snugly against the lips of the Kjeldahl flasks, acid film is formed between them. When the suction becomes just enough to suck the fumes from each flask, the acid film remains and prevents the free entrance of air. The results are: (*a*) the necks of the Kjeldahl flasks become very hot, (*b*) shaking becomes very inconvenient, and (*c*) only very little acid is condensed. Consequently, the greater portion of the acid fumes is sucked into the sink, and as a result many of the samples become dry before digestion is completed.

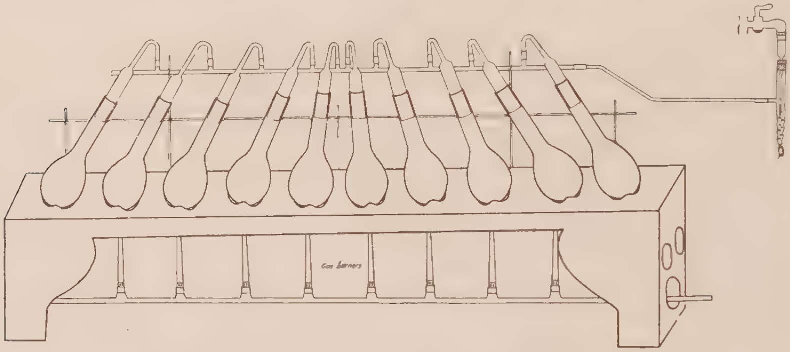

Fig. 1.—A set-up of the modified apparatus

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[1] Experiment Station contribution No. 1257.

[2] Catalog for Laboratory Apparatus and Reagents of Arthur H. Thomas Company, Philadelphia, U.S.A., 1931 Edition, p. 585.

While this paper was being prepared, Clark's[3] work on a similar digestion apparatus was published. This apparatus differs from Sy's in that each unit is provided with a suction pump. Incidentally, our modified set-up of the Sy's apparatus is also an improvement upon Clark's in that the individual suction pump of each unit was eliminated. With the usual laboratory glass blowing facilities, all the parts were made in the laboratory. The set-up of the modified apparatus is shown in figure 1. It is giving very satisfactory results at present, and all our digestion work is being done outside the hood on the analytical table. In the present set-up the two bulb connecting tubes of the Sy, and the Clark apparatus were replaced by simple connecting tubes. Also in contrast to Sy's, and to Clark's arrangement, the connecting tubes have no bulbs that fit snugly against the lips of the Kjeldahl flasks. The connecting tubes are made loosely fitting to allow air to enter when the suction is in operation. About 12 cm. of the connecting tube projects into the neck of the Kjeldahl flask.

The entering air forces down the fumes below the end of the connecting tube and cools automatically the upper portion of the necks of the Kjeldahl flasks, thereby enabling the analyst to shake or manipulate the flasks with ease, comfort, and safety during the digestion operation.

The advantages of the modified apparatus may be summarized as follows:

1. The rubber dissolved by the acid fumes is always carried into the sink.

2. Shaking the flasks during digestion is very convenient as the necks of the Kjeldahl flasks are continuously cooled by the entering air.

3. There is very little acid wasted. The air forces down the greater portion of the fumes to the bottom of the Kjeldahl flasks. In the Sy's and the Clark's apparatus all the fumes are sucked into the sink.

4. A strong suction pump is not very essential as the air forces down the fumes and only a small quantity of these are sucked into the sink.

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[3] CLARK, WESLEY M. 1937. A Kjeldahl digestion apparatus. Ind. Eng. Anal. Ed. 9: 338–39.

A REVIEW: "TROPICAL FRUITS AND VEGETABLES: AN ACCOUNT OF THEIR STORAGE AND TRANSPORT"[1],[2]

Realizing the usefulness of information that will lead to a more successful "storage and transport of a number of fruits and vegetables indigenous to or capable of being grown in the tropics", Dr. C. W. Wardlaw painstakingly brought together from widespread sources rather fragmentary notes on the subject in a useful, well presented treatise.

Fruits and vegetables, like other organisms, are living, requiring not only care in handling but also precision in all the other steps involved, from picking to the disposal of the products. These steps include attention to degree of maturity at harvest, pre-storage treatment, optimum storage temperature, and composition of the air in the storage chamber. These, in addition to other information on the important physico-chemical changes which take place in fruits and vegetables while in storage and the economics of handling the commodities, are discussed in detail by Doctor Wardlaw in his memoir.

The use of an optimum temperature alone will help materially in bringing about more satisfactory results in storage. For, especially in the tropics, where the market life of most fruits and vegetables is far too short to allow of their proper disposal, the problem of efficient storage is still an important one. Upon the practical solution of this depends, to a large extent, the greater output of these products. Not only would the season be lengthened, but prices would also be more stable.

Theoretically, temperatures higher than the freezing point of the sap, sufficient to allow for imperfections of refrigerating devices are ideal for storage purposes; but actually, the allowance for certain products far exceeds this value owing to interference with various necessary processes of life. Thus, the optimum temperature and other storage conditions for each product can only be determined by careful tests.

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[1] WARDLAW, C. W. 1937. Tropical fruits and vegetables: An account of their storage and transport. Low Temperative Research Station, Imperial College of Tropical Agriculture, Trinidad, B. W. I., Memoir 7: 1-244.

[2] General contribution No. 620.

While most of the discussions in the book are based on experiments performed in other countries they supply information that may be used for improving some of the less efficient local practices.

Thirty-nine kinds of fruits and forty-two kinds of vegetables, including those of promise for culture on commercial scale, are considered.

The publication should be of particular interest to producers and those who deal with these highly perishable commodities. After each topic, the author gives a long list of references which should be of special interest to those who wish to make a detailed study of the subject.

Copies of the publication may be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B. W. I. at about ₱2.25.

L. G. GONZALEZ
Of the Department of Agronomy

COLLEGE AND ALUMNI NOTES

The following papers were read at the one hundred and thirty-third scientific meeting of the Los Baños Biological Club held in the lecture hall of the Agricultural Botany Building on August 25:

Mr. R. P. Estioko. Weather observations at the College of Agriculture during 1924-1937.

Dr. F. M. Salvoza. The dipterocarps in the U. P. Land Grant, Basilan Islands.

Dr. F. O. Santos and Mr. J. K. Demeterio. Studies on the food of 121 families of laborers in Macrohon, Leyte. Paper read by Mr. Demeterio.

Mr. Santiago R. Cruz sailed on August 29 for the United States as a pensionado of the Philippine Commonwealth to take advanced courses in Agricultural Engineering at Cornell University.

Mr. Gerald Sydney, Professor of Voice Production, Elocution, and Piano and formerly a member of the faculty of the Royal Academy of Music in London was a convocation speaker at the College of Agriculture auditorium on Wednesday, September 14.

Dean Paul C. Packer, one of the advisers in connection with the reorganization of the University of the Philippines, together with Mrs. Packer and President Bocobo, visited the College on Thursday, September 22. The visitors were entertained by Dean and Mrs. B. M. Gonzalez.

Papers read at the one hundred and thirty-fourth scientific meeting of the Los Baños Biological Club held in the lecture hall of the Agricultural Botany Building on September 29 were as follows:

Dr. M. Manresa, Mr. N. Pepito, and Mr. A. L. Silva. The comparative efficiency of pasture improvement methods. Paper read by Doctor Manresa.

Dr. N. Galvez. The chemical and physical composition of the fine ejecta of Mayon Volcano.

Mr. F. Pantaleon. What would be the ultimate effects upon the growth and yields of rice plants of rice straw, rice straw ash, or both when added to Lipa clay loam at different times?

A paper by G. O. Ocfemia and M. S. Celino, of the Department of Plant Pathology, describing the transmission of abacá mosaic to abacá and the wild *Canna* from Davao by *Aphis gossypii* Glover and by two other aphids, is now in press in *The Philippine Agriculturist*.

FARM TENANCY PROBLEMS IN THE PHILIPPINES WITH PARTICULAR REFERENCE TO TENANCIES IN RICE-PRODUCING REGIONS[1]

José E. Velmonte
Of the Department of Agricultural Economics

WITH FOUR CHARTS

Farm tenancy has become an important agricultural problem in the Philippines. Armed resistance, strikes, and destruction of property in some *haciendas* are alarming signs of increasing restlessness among the farm workers. Thoughtful men in high government quarters, keenly aware of a potentially dangerous situation, are exploring the possibilities of solving permanently the problems of farm tenants. Tenancy, however, is not a new problem in Philippine agriculture. Spanish conquerors, soon after the discovery of the Islands were established by the Crown in *encomiendas* which were the Spanish colonial version of the feudal economy of medieval Europe. This system was later abandoned, but powerful religious corporations became owners of great landed estates, which gave rise during the latter part of the 19th century to a rebellious and embittered body of landless peasantry. Hence, the farm tenant of today is the survival of centuries of land tenure which created an economic class not far removed from serfdom.

Scope of this study

During a period covering the last fifteen years, a number of tenancy surveys have been made by members of the staff and major students of the Department of Agricultural Economics of the College of Agriculture. It is felt that much of this material hitherto unpublished may prove of some value. Hence, the main results of these studies are here presented. With the exception of the tenancy studies by Hester, Mabbun, and others (1924), all other investigations cited in this paper and indicated in footnotes are by students whose surveys were planned and carried out under the direction of the writer.

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[1] Read before the fourth plenary session of the Fourth Alumni Institute, University of the Philippines, Manila, March 24, 1938. Experiment Station contribution No. 1262.

THE PHILIPPINE AGRICULTURIST, VOL. XXVII, No. 7, DECEMBER, 1938.

The 1918 census showed that of the nearly two million farms in the country, over 22 per cent were under various forms of tenancy. Compared with figures of the 1903 census, this represents an increase of over four per cent. In the absence of a census later than 1918, the extent of tenancy at present is a matter of conjecture. From the results, however, of our various tenancy surveys and from other relevant facts, tenancy apparently has shown no diminution. No figures based on crops are available, but tenancy seems more prevalent in the production of rice than of other crops. Hester, Mabbun, and others (1924) estimated that 70 per cent of all tenants are associated with the growing of rice.

The importance of the rice industry in the economy of the country is well known. Its acreage is fully one-half the total area devoted to the nine principal crops. As a result, the problems of the share croppers in rice affect the majority of those engaged in our agriculture; hence, this paper refers particularly to conditions of tenancy in the rice industry.

Tenancy, a serious Philippine problem

The consensus of opinion is that there should be only one ultimate land tenure policy in the Philippines, a system that should lead finally to farm ownership by everyone who works the soil. Such a policy in other countries has created the peasant proprietary system as found in France, Ireland, Italy, and Denmark, in contrast with the preponderance of farm tenancy in England (Chart 1).

This opinion is largely premised on the fact that tenancy is not normally a problem of new and undeveloped countries like the Philippines. With a vast public domain available for agriculture, estimated to be no less than twelve million hectares[2], and with the progressive liberalization of our homestead laws, the extent and increase of tenancy seems quite without justification. Some authorities hold that tenancy is a necessary step in the acquisition of land by the operator, but our surveys show that in this country it is not a step to farm ownership. Eight widely scattered surveys of farm tenancy (Hester, Mabbun, and others 1924) including a total of 830 tenants, showed that (*a*) the average age of the tenant was 41; (*b*) the tenant class was a fixed caste, marrying largely within its class, and finally, (*c*) tenancy was heavily weighted with debt which precluded any possibility of the tenant's saving capital for independent farming.

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[2] Bureau of Forestry estimate. Economic problems of the Philippines. xix + 270 p. Manila: Bureau of Printing.

Our surveys of farm ownership drew the same conclusion that farm tenancy was not a usual rung of the agricultural ladder. Of 389 farm owners surveyed in Pangasinan, only 3.3 per cent had worked as tenants previous to ownership.[3] The usual ladder had two rungs: a farm boy works with his father on the home farm until the latter's retirement or death when he assumes possession through inheritance. Our surveys in Laguna[4] and Bohol[5] also showed that tenancy was not the usual step to ownership.

Those who accept tenancy further contend that not all tenants, even under ideal conditions, can eventually own farms. Among those believed incapable of achieving ownership are those deficient in managerical skill and those not only incompetent but also thriftless and ignorant. Even if tenancy is conceded to have a place in land tenure, the above facts make it a serious problem in the Philippines. As Bizzell has so aptly said, "farm tenantry becomes a menace to progressive society...when the conditions under which the

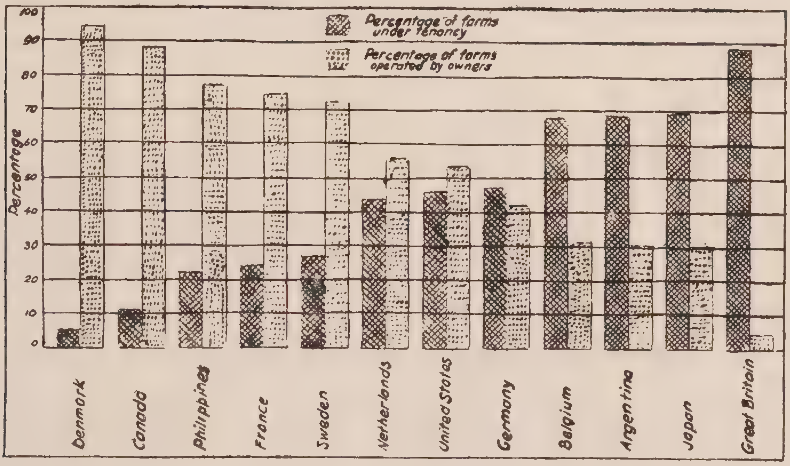

Chart 1.—Showing farm ownership and tenancy in various countries (After G. S. Wehrwein)

land is cultivated are such as to tend constantly to reduce those who cultivate the soil to a class status."[6]

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[3] CABRERA, D. 1930. A study of farm ownership in five typical farming towns in Pangasinan. The Philippine Agriculturist **19**: 179–191.

[4] MALABAYABAS, G. A study of farm ownership in Los Baños, Calamba, and Bay, Laguna. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1931. Unpublished).

[5] BONGATO, D. S. Farm ownership and tenancy in eight selected municipalities of Bohol. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1933. Unpublished).

Farm tenancy is both an economic and social problem. As a form of land tenure, it is ruinous because tenants are apt to drain the soil of fertility, and thus cause decline in value of output and farm property. Tenancy is likewise a danger to our social institutions. As transient occupants of the land, tenants have little interest in community progress and betterment. It leads to the separation of men into antagonistic classes. Thus, we find at present tenants on a number of farms demanding improvement of their economic status by strikes, destruction of property, and even murder to accomplish their ends. If this continues, the very foundation of our social and economic life will be undermined.

FACTORS FAVORING THE GROWTH OF TENANCY

It is, therefore, of interest to analyze those economic and social factors which have favored the existence and growth of tenancy in the Philippines despite a vast area of free land and a liberal public land policy that should normally prove accelerating factors of farm ownership.

The slow disposition of the public domain

Despite the fact that the public land policy is for the promotion of farm ownership by the greatest number, as shown by a very liberal homestead law and strict area limitation to prevent concentration of land ownership, an insignificant portion of the public domain has been acquired and patented as homesteads. From the passage in 1903 of the land law to 1937, a period of 34 years, the total area applied for as homesteads was nearly 3,500,000 hectares, of which only 1,800,000 hectares were approved for entry. Of this, less than 600,000 hectares have been patented by slightly over 63,000 homesteaders, or an annual average of 1,800 homesteaders have acquired title to about 18,000 hectares[7] (chart 2).

One explanation for the meager results is that the essence of our public land policy is laissez-faire; that is, the acquisition of land is left to individual initiative with hardly any government aid to the settler in the very difficult task of converting virgin land into a farm. Experience in other countries amply shows that such a

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[6] BIZZELL, W. B. 1921. Farm tenantry in the United States. Texas Agric. Exper. Sta. Bull. 278: 1–408.

[7] Bureau of Lands' figures. From a letter of the Director to the writer under date February 14, 1938.

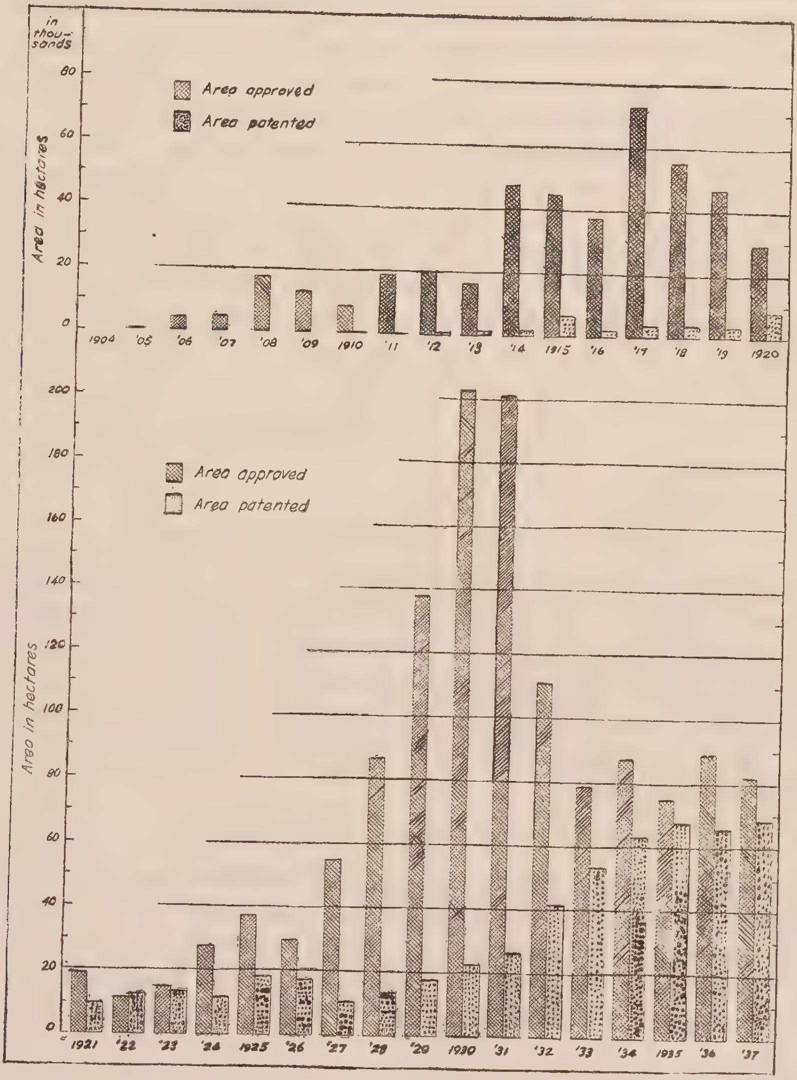

Chart 2.—Showing the rate of disposition of the agricultural public domain in homesteads

policy can but result in an unsystematic and slow disposal of undeveloped lands. Our studies of the experiences of 203 pioneer farmers in the homesteaded regions of southeastern Tayabas[8] and Nueva Vizcaya[9] revealed some of the problems of settlers. It was found that one who contemplates taking government land in those regions has to face many hardships, some quite beyond his power to remedy. Among these difficulties are: the slow and expensive method of clearing virgin land, the delays by the government in granting titles, the lack of capital, and the absence of roads.

Because of an uneven distribution of population, high land values prevail in certain highly developed sections of the country, despite the abundance and cheapness of land in comparatively undeveloped regions. Thus, relatively high land values prevail in Pampanga, where the ratio of total assessed valuation to total agricultural area for 1934 was ₱487 per hectare; in Nueva Ecija, ₱241; and in Negros Occidental, ₱240. In contrast, cheap land prevails in Bukidnon, where the ratio is ₱7 per hectare; in Cotabato, ₱7; in Davao, ₱32; and in Nueva Vizcaya, ₱37.[10] It is, therefore, not surprising that in provinces like Pampanga, Nueva Ecija, and Occidental Negros, tenancy presents serious problems, whereas, in undeveloped provinces, it does not.

The suitability of tenancy to rice farming

Students of tenancy point out that the type of agriculture has a bearing on tenancy. That it is usually associated with rice growing is not accidental. It has been proved elsewhere that where methods of cultivation are simple, involving no complicated rotation systems, and when a crop can be grown by ignorant and unskilled labor using simple, inexpensive implements, farm tenancy as a method of tenure takes root easily.

Low labor income of the tenant

One of the principal causes for the existence and permanency of tenancy in the Philippines is that the rice cropper receives a very low remuneration for his labor. A study of his income is important as it serves as an index of his level of living and his chances of ultimately owning a farm. The Department of Agricultural Economics has made several studies to determine the labor income of a share cropper in rice production (chart 3). Hester, Mabbun, and others (1924) reported a labor income per hectare for tenants of ₱51.40, or ₱123.36 per tenant on an average holding of 2.4 hectares. In a study of 54 tenancies in Batangas growing upland rice, we have found that the average labor income was ₱63.73 from an average tenant holding of 2.6 hectares.[11]

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[8] LAYOS, E. O. Some economic aspects of the settlement of lands of the public domain in Tayabas. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1932. Unpublished).

[9] DANAO, N. A. Some economic aspects of the settlement of lands of the public domain in Nueva Vizcaya. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1933. Unpublished).

[10] Computed from figures in the Philippine Statistical Review, Special Supplement, Vol. 2. 1935. Department of Agriculture and Commerce.

In a study of 105 croppers of Nueva Ecija growing lowland rice, it was found that the average labor income was ₱29.80 per hectare or a total of ₱101.32 per tenant for an average holding of 3.4 hectares.[12]

Finally, in our carefully supervised 5-year study of farm tenancies on the College farm from 1931 to 1936, including an average of 20 tenants raising among other crops, lowland rice, the average labor income from rice on an average holding of less than 1.5 hectares was never above ₱100.[13]

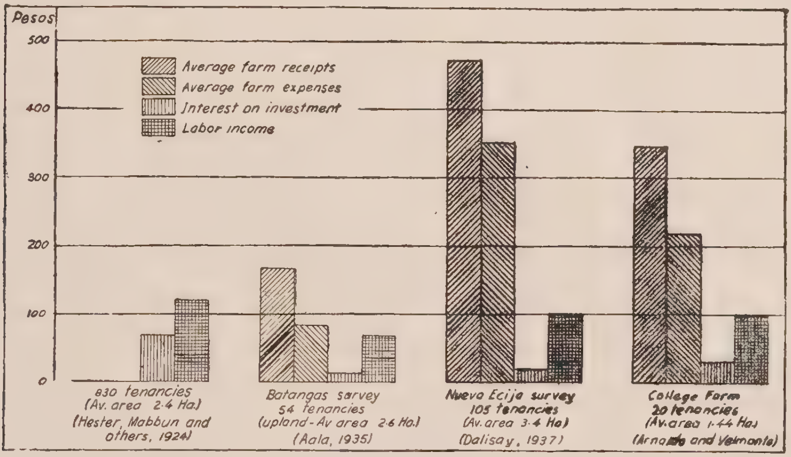

Chart 3.—Showing the labor income of the tenant in rice production

Although results of our different surveys are naturally not in close agreement as they were made in different regions in different years and under varying conditions, they show that the average labor income of a share cropper on a rice farm varying from somewhat over 1 hectare to 3 hectares is not more than ₱130. With supplementary incomes, the farm income per tenant family, according to these figures, may be placed at about ₱200 annually. This means that a family of from 5 to 6 members has to live on about ₱200 per year, or below subsistence level. Can one wonder why many tenants are perpetually indebted to their landlords when their incomes in any year can barely support their family?

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[11] AALA, P. L. An economic and social survey of tenancies in the municipality of Tanauan, Province of Batangas. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture. 1935. Unpublished).

[12] DALISAY, A. M. 1937. Factors related to income and cost of production of rice on tenant holdings in Cabiao, Nueva Ecija. The Philippine Agriculturist 26: 730–756.

[13] Preliminary figures from a 5-year cost accounting study of tenancies on the College farm (Arnaldo and Velmonte).

The low labor income is partly due to the relatively small size of the farm, but on closer analysis, it is more largely due to the highly seasonal character of rice production. As a result, the tenant's labor time is surprisingly small. Thus, in our Nueva Ecija study [14], the total labor time of the cropper averaged 873 hours on an average holding of 3.4 hectares. On an eight hour day, this is equivalent to about 109 working days. With an average labor income of ₱101.32, the tenant is paid, therefore, on the basis of ₱0.93 per day. This return is not quite on a par with wages of many workers in industry. Obviously, employment of the tenant's idle time, which constitutes about two-thirds of the year, should increase the family income without enlarging the farm he operates. With such labor incomes as presented above, the share cropper has not the remotest chance of acquiring sufficient capital for independent farming.

The lease contract

Students of tenancy consider the lease contract as the most important feature of tenant farming, for the well being of the tenant often depends on the provisions of the agreement he makes with the landlord. A study of tenancy contracts in Nueva Ecija shows that much of the discontent of croppers is directly traceable to oppressive exactions by landlords in seemingly fair contractual arrangements. Eighty-eight farms with a total of 12,118 hectares and worked by 3,297 tenants were surveyed in 12 municipalities of Nueva Ecija during 1935.[15] The tenancy contract is usually written and a copy printed in a *libreta* is given each tenant. The usual contract provides the following:

> Land is furnished by the landlord; work animals, tools and implements, by the tenant.

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[14] DALISAY, A. M. *op. cit.* table 3, p. 753.

[15] DALISAY, A. M. 1937. Types of tenancy contracts on rice farms of Nueva Ecija. The Philippine Agriculturist 26: 159–198.

Land preparation and other expenses not specified below are borne by the tenant.

Seed is advanced by the landlord.

Transplanting expenses are either borne by the landlord alone or shared equally with the tenant.

Irrigation expenses are shared equally.

Harvesting expenses are either borne by the tenant alone, or shared equally with the landlord.

Threshing expenses are shared equally.

Hauling of the crop to the warehouse is done by the tenant.

(In cases where the expenses are shared equally, the part corresponding to the tenant is advanced by the landlord.)

The division of the crop is as follows: From the total product harvested, the seed, threshing charges, and those farm operating expenses shared equally by both parties are converted into palay and deducted from the gross harvest. The net product is then divided equally between landlord and tenant.

In addition, however, to these written terms of the usual contract are implied agreements on loans made by the landlord to the tenant which in practice seriously impair the equity of the contract. These loans consist essentially of three types:

(1) Expenses of operation when shared with the tenant are advanced by the landlord, payable by converting it in kind on the basis of 1 cavan for every ₱1.00 to ₱1.20 advanced.

(2) Food rations of two types, a limited ration of from 2 cavans to as high as 20 without interest, and additional rations in excess of the limit, payable on the basis of 1½ cavans palay for every cavan of ration.

(3) Cash loans which are converted into palay on the basis of 1 cavan for every ₱1.00 to ₱1.20 borrowed, or in rare cases, on the basis of the current price per cavan at settlement less from 20 to 25 centavos.

In some farms, less onerous terms on loans are incorporated in the printed contracts. In many cases, however, these oppressive rates, merely understood between the tenant and landlord, apply. This is possible because the tenant has no bargaining power and often has no choice but to accept the conditions imposed or else seek in vain for better terms elsewhere.

The net result of these oppressive terms on loans is to keep the tenant perpetually indebted. The landlord has a lien[16] on the tenant's share of the crop, which is often hardly sufficient to liquidate the debts heavily weighted with high rates of interest.

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[16] With the passage of the Philippine share tenancy act No. 4054, 15 per cent of the tenant's share of the crop is exempt from the landlord's lien.

Bizzell [17] believes that a lease is fair when the parties to the farm enterprise are compensated as follows:

(1) Remuneration for all labor, manual and managerial;

(2) Reimbursement in full for all funds paid out for operating expenses such as feed, fertilizer, and similar operations;

(3) Interest on capital investment at a reasonable commercial rate on land, implements, and stock;

(4) Interest on all money advanced for operating expenses;

(5) Depreciation of the farmstead.

It is interesting to evaluate the equity of the typical tenancy contract in Nueva Ecija as revealed in our studies on the basis of the above principles and as suggested by Sir Richard Paget and E. H. Webster, and by H. P. Miller.[18]

Paget and Webster view the contractual relation between the landlord and tenant as a partnership and consider an equitable division of profits on the basis of the capital investment contributed by each. Following their procedure and on the basis of representative figures obtained in our Nueva Ecija survey, it was found that the total capital investment of the landlord was valued at ₱3,292.78; and of the tenant, ₱3,483.70, or, a total of ₱6,776.48. According to Paget and Webster, an equitable division of the produce should be on the basis of the ratio of their capital investment, or, 48.59 per cent for the landlord, and 51.41 per cent for the tenant (chart. 4). The half-and-half division of the crop provided for by the typical tenancy contract in Nueva Ecija approaches in a remarkable degree what in the opinion of Paget and Webster should be an equitable distribution.

H. P. Miller maintains that an equitable distribution of the farm produce between landlord and tenant should be based upon a ratio of the actual money value of what each party puts into the farm business. The landlord is entitled to a normal return on his capital investment in land and buildings. Likewise, the tenant and his helpers are entitled to a normal compensation for their labor. Tenant capital is likewise entitled to the same rate of return as that of the landlord. After deducting running expenses as fertilizer, seed, and others, an equitable distribution of the produce, according to Miller, should be based on the ratio of what constitutes the normal return of the landlord and what is considered the normal compensation of the tenant.

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[17] BIZZELL, W. B. *op. cit.*, p. 189.
[18] *Ibid.*, pp. 190–195.

Subjecting the typical tenancy contract in Nueva Ecija to this test, (chart 4) it is found that the normal return of the landlord on his investment at the current rate of interest (7 per cent) is ₱224. The normal compensation of the tenant and helpers at current wages (₱1.00 per day of 8 hours) as well as a normal return on his investment amounts to ₱217.86. The ratio of their respective returns is 50.69 per cent for the landlord, and 49.31 per cent for the tenant. According to Miller this should be the equitable basis of distribution of the farm produce. Again, it is shown that the half-and-half division of the crop in the tenancy contract in Nueva Ecija is almost identical with Miller's equitable contract.

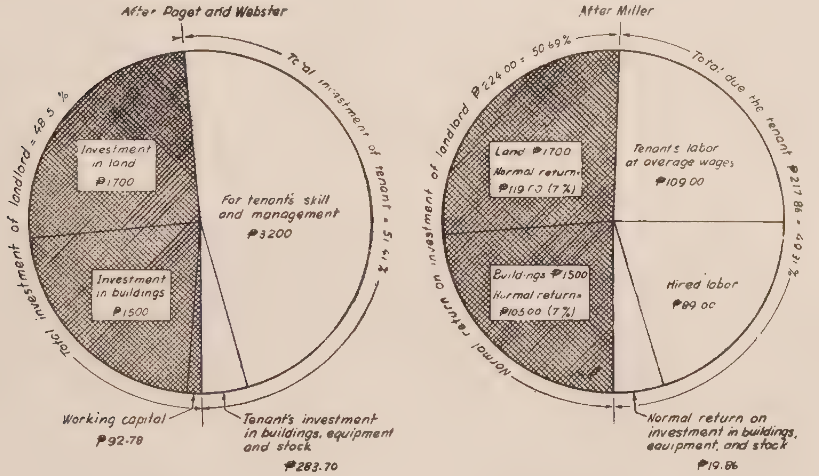

Chart 4.—Showing the equity of rice tenancy contracts in Nueva Ecija

The results of the above analyses show that tenancy contracts in Nueva Ecija when stripped of implied agreements on loans are reasonably fair and equitable.

Social factors favoring the growth of tenancy

Social factors favoring the growth and existence of tenancy in the Philippines are interrelated with economic causes. The share cropper belongs to the most ignorant and poorest class. Socially, his status is the lowest partly because of lack of educational opportunities. In turn, his ignorance and lack of education are due to his proverbial poverty. In a comparative study of the standard of living of peasant proprietors and tenants (Velmonte, Sumagui, and Viray, 1934), the extent of formal education received by children was demonstrated as lowest among tenant families. It is apparent that with the landlord dominant socially, economically, and politically, the cropper becomes an unequal and helpless partner in crop production.

The landlord has been pilloried before the public, but in fairness it should be said that he too, is the victim of a system beyond his control. The cropper is not only ignorant but shiftless and improvident, often ready to squander his earnings in a few days of merriment, oblivious of his responsibilities. As a consequence, advances, rations, and loans are inescapable obligations of a landlord to his tenant if he is to keep his farm business going. The landlord feels justified, therefore, in assessing burdensome rates of interest in view of the great risks involved in lending to a bankrupt partner in production.

POSSIBLE LINES OF SOLUTION OF THE TENANCY PROBLEMS

Since the belief is general that the ultimate land tenure policy for the Philippines should lead finally to farm ownership by everyone working the soil, and since it has been shown that a degree of tenancy is unavoidable in any well-ordered system of agriculture, the goal of our agricultural policy would seem to be two fold: first, to encourage all efforts to enable every farmer of ability, energy, and ambition, to achieve ownership; and second, to devise a rational system of farm tenancy that will protect the tenant's rights so as to promote a program of distributive justice.

An effective land settlement policy

The Philippine government has the means of promoting farm ownership. Some measure must be devised to overcome the inertia of the laissez-faire policy in the disposal of the public domain. The experience in other countries shows that only by organized land settlement under state direction and aid can the policy of promoting farm ownership be vigorously prosecuted. Denmark, Germany, Ireland, England, Australia, and New Zealand have adopted land settlement policies involving in various ways direct state aid to the settler.

The problems of Australia and New Zealand in trying to bring about a rapid development of unoccupied lands and the means they have employed should be of interest to this country. The government of New Zealand financed the development of unoccupied lands to cause denser settlement and create small, independently operated farms. Loans at low interest payable over periods as long as thirty-six years were made to settlers to buy the land and make necessary improvements. Australia adopted a similar land policy.

Out of the experiences of these countries and others have evolved certain basic principles successful for this type of land settlement: namely, selection of settlers, financial aid to them on a basis of long-time payments for land and improvements, organized construction of farm improvements including highways, and provision for technical advice and expert supervision in conducting the farm enterprise.

State purchase of large estates

Some large estates, notably those in the possession of some religious corporations still exist in the Philippines. In view of frequent troubles in these, their purchase and resale to tenants is contemplated. The experience of Ireland, where tenancy at the opening of the nineteenth century was perhaps at its worst, is notable. By a series of land purchase acts, about 400,000 holdings, representing more than three-fourths of the soil of the country, have passed into the hands of tenants. This was accomplished by a land purchase program in which the government advanced the purchase price and then sold the land to tenants on the basis of annuities as low as from 3¼ to 4 per cent with ownership secured after forty-nine to sixty-eight years.

As pointed out by the writer (Velmonte, 1937), this plan requires a careful study, for many of the tenants are probably not in a position to take advantage of a land purchase program of the government. Certain principles need to be observed: namely, selection of prospective purchasers on the basis of certain standards of experience, capacity and stability, long-term financing with no down-payment, with annual payments lower than rents, and finally, sustained government help and guidance. Furthermore, a trial-lease period to determine ultimate capacity may be tried, and the right of a tenant purchaser to alienate his interest in the land, limited. However, this method of promoting farm ownership should yield precedence to the settlement of the public domain, for that which may be invested in the purchase of the friar estates could easily finance a larger program for settling the public domain which would benefit in the end a far greater number of farmers.

A rational program for tenants

Hand in hand with these measures to encourage farm ownership, a program of rehabilitating tenants should be pursued in order to improve conditions of farm tenancy for those who may not be able, even under ideal conditions, to achieve ownership. This seems as imperative as the measures to promote farm ownership.

Economic rehabilitation of tenants is sorely needed. Lease contracts need adjustment; because of the helplessness of the tenant, the government should do this by legislation. Already, the rice tenancy law is a step in that direction. A sound program of credit reform under state direction is imperative if the tenant is to be freed from burdensome rates of interest on loans. The Philippine National Bank is starting measures along this line, as for example, its agency loans to accommodate small borrowers. Opportunities must be created to enable the tenant to utilize his labor most of the year. Very small holdings should be enlarged to an economical size.

The cropper also needs social rehabilitation. Educational opportunities, health improvement programs, and other measures that can be promoted by social agencies to make farm life happier and fuller of opportunity should find a place in a bread program of rehabilitating the share cropper.

SUMMARY

1. Farm tenancy is a problem demanding attention and solution in the Philippines today. It is largely associated with rice production which, in view of the preponderance of the rice acreage, affects the majority of those engaged in our agriculture.

2. With a liberal land policy in the disposal of the public domain, the extent and increase of tenancy is without justification. Also when it is shown that tenancy is not a rung of the agricultural ladder, it becomes an even more serious problem.

3. Economic and social factors are responsible for the extent and growth of tenancy in the Philippines: namely, the slow disposition of the public domain, the suitability of rice farming to tenancy, the low labor income of the tenant, the oppressive exactions of burdensome rates of interest on loans in what are otherwise fair lease

contracts, and finally, the ignorance and thriftlessness of tenants which make them helpless.

4. Possible lines of solution of the tenancy problem may be found in a more effective land settlement policy to accelerate farm ownership, state purchase of large estates, and finally, a rational program of economic and social rehabilitation of tenants.

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MOISTURE CONTENTS OF CLAY LOAM AT THE TIME OF WILTING OF RICE PLANTS OF DIFFERENT AGES [1]

LEONCIA L. SERRANO

WITH THREE TEXT FIGURES

The growth and development of rice are decidedly influenced by water. Palis (1935) found that by varying the moisture contents of the clay loam in pots, he was able to alter the growth and development as well as the yield of grain of the plant.

The writer planned to study the wilting coefficient of clay loam when planted to rice of different ages. As the work progressed, however, it was found difficult, or impossible, to determine with certainty the exact wilting coefficient of the soil because the different leaves of the same plant did not permanently wilt at the same time. Most commonly, once the leaves had rolled upright or even though apparently still standing erect, they never regained their original stage of turgescence even though they were exposed for twenty-four hours to a practically water saturated atmosphere in the dark. In this paper the writer presents data on moisture contents of clay loam at the time of wilting of the rice plants of different ages.

Review of literature

Briggs and Shantz (1912) appear to be the first investigators to use the term wilting coefficient "to denote the moisture content of the soil (expressed in percentage of the dry weight) at the time of the permanent wilting of the plants growing therein." They found that the loss of water from the soil through the plant did not cease at permanent wilting, but it went on to some extent even after the death of the plant.

The difficulty that was experienced in this study in connection with the determination of the condition of the rice plants that could be considered to have just reached the stage of permanent wilting confirmed previous general observations on the subject. The present study which was a modified direct method of determining wilting coefficient is considered satisfactory only for seedling plants grown in small sealed containers. But even with the young plants, it was found "almost impossible to obtain a sharp end point for wilting", and according to previous work "in large containers the soil moisture is not evenly depleted throughout the soil mass".

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[1] Experiment Station contribution No. 1263. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

The amount of water that remained in the soil at the time of permanent wilting depends upon various factors. According to Miller (1931) the chief factors are the type of soil, the climatic conditions prevailing, and the kind of plant. Miller further states that Sachs was the first to notice that the amount of water left in the soil at the time of wilting depends upon the type of soil. He found that tobacco wilted permanently in a vegetable mold with 12.3 per cent of water, in loam with 8 per cent of water, and in sand with 1.5 per cent. Briggs and Shantz (1912) employed twenty different types of soil, ranging from coarse sand to clay loam, and obtained similar results.

Briggs and Shantz (1912) studied also the influence of climate on wilting coefficient. They state that for a given soil the wilting coefficient was constant regardless of the nature of the climatic conditions prevailing at the time of wilting and regardless of the type of plant. These observations, however, were not confirmed by the studies of Brown (1912) who found that the rate of evaporation previous to the time of wilting determines the percentage of moisture that the plant can not extract from the soil.

Caldwell (1913) repeated some of the work of Brown and found that for a series of plants grown in any one soil and wilted under a number of aerial conditions, as many different soil moisture contents were obtained as there were sets of conditions. Shive and Livingston (1914) obtained similar results. Among the results they obtained was that the amount of water that remained in a given soil when a plant permanently wilted was subject to the influence of the atmospheric conditions that prevailed just previous to the time of wilting.

The difficulty in obtaining a uniform or simultaneous wilting of the leaves of rice was previously observed by Crump (1913) with other plants. This investigator found it difficult to determine the wilting point in the case of fully developed plants because as the water content of the soil became low, the lower leaves of the plant drooped, dried up, and dropped off, while the upper ones continued to be turgid and functioned normally.

In the present study only one type of soil, the clay loam, and one kind of plant, rice, were employed in order to reduce to the minimum the sources of errors for a comparative study on moisture content. With rice, very few older leaves drooped and none dropped off. The leaves always remained on the plant but they rolled upright as they became dry. At this stage, the older leaves had completely lost the power of regaining turgescence even when placed in a moist chamber; only the very young leaves persisted in remaining green and somewhat fresh for some time.

Objects of this study

The object of this study was to determine the moisture contents of soil in pots at the time of wilting of the leaves of rice plants 30, 60, or 90 days of age.

Time and place of this study

The culture part of this study was carried out in the experimental yard of the Department of Agricultural Botany. It was begun in February, 1937, and ended in April, 1938.

MATERIALS AND METHODS

The plant

Upland rice, variety Inintiw, was used. The seeds, obtained from the Department of Agronomy, were soaked in water for twenty-four hours. They were then planted in pots four seeds to a pot. When the seedlings were about five centimeters high, some of them were pulled up, leaving only two uniformly developed and healthy plants in each pot.

The soil

Clay loam taken from a lot in the Rural High School Reservation was placed on a concrete floor to dry in the air. When sufficiently dry, the soil was pulverized, passed through a screen of 1 cm. sq. holes and mixed thoroughly. Six kilograms of the air-dry soil were placed in each pot.

The cultures

Ten culture trials were conducted almost monthly during the period from February 15, 1937, to April 15, 1938. Each trial consisted of more than thirty cultures. But only thirty cultures were actually employed; the rest were either allowed to die or were discarded. The thirty cultures in each trial were grouped into three sets, ten cultures in each set. In the first set the plants were allowed to wilt at the age of about 30 days. The plants in the second set were allowed to wilt at the age of about 60 days; while the plants in the third or last set were deprived of their supply of water at the age of about 90 days.

The cultures in the first trial, were started on February 15, 1937. About one month later, the ten cultures in the first set were placed under shelter and deprived of water. About two to ten days later, depending upon dryness of the atmosphere and the amount of water in the soil, the plants began to show signs of wilting. Then day by day, two cultures each day, the plants in each set were placed in the moist chamber for twenty-four hours.

In the meantime the cultures in the other two sets, the 60-day old plants and the 90-day old plants, were left exposed to the sun. At the end of another thirty days, ten of the plants which had reached the age of 60 days were transferred to the shelter and as in the first set, the plants were deprived of water. At the sign of wilting, two cultures each day were placed in the moist chamber for observation on recovery of turgidity of the leaves.

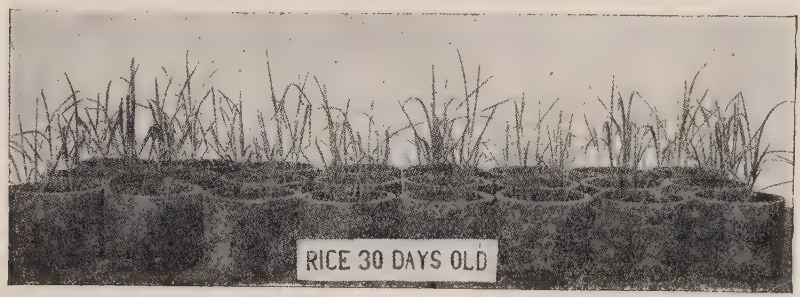

Fig. 1.—Rice plants, variety Inintiw, 30 days old, grown on clay loam in pots soon before they were forced to wilt by withholding the supply of water.

When the third or last set of ten cultures had reached the age of 90 days, they were likewise transferred to the shelter and deprived of additional water. Again when signs of wilting of the leaves became apparent, the cultures, two at a time, were placed in the moist chamber as in previous cases.

The cultures in the second, third, fourth and up to the tenth trial, were similarly treated, but the dates when the cultures were started and when the various treatments were made were different. To show the conditions of the cultures soon before additional water was withheld, the cultures in trial VI were photographed, (fig. 1, 2, and 3). These cultures were run from September 25 to 29 in the case of the 30-day old plants; from October 26 to 30 in the case of the 60-day old plants; and from November 24 to 28, 1937, in the case of the 90-day old plants. Owing to the fact that this culture trial was made somewhat off-season and the soil was not fertilized, the plants were not as vigorous as those grown in season.

Care of cultures

All the cultures were exposed to the sun, and from time to time they were weeded, cultivated, and watered with equal amounts whenever necessary.

Determination of moisture content of soil and of leaves at the time of wilting

The soil. At first the plants received the usual amount of water; the soil was merely kept moist. On reaching the age of 30, 60, or 90 days, further supply water was withheld until the leaves showed signs of wilting. Then from day to day, two cultures each time, samples of soil were taken from pots by means of a cork borer. The samples were placed in crucibles and at once, one by one, they were weighed in an analytical balance. Then the samples were placed in an electric oven at 100°C. to dry to constant weight.

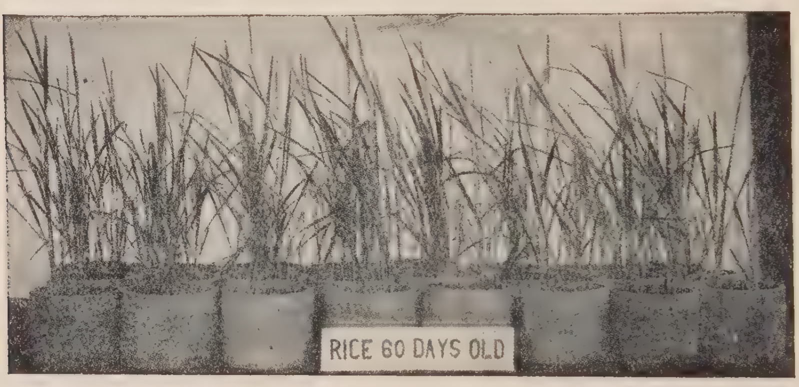

Fig. 2.—Rice plants, variety Inintiw, 60 days old, grown on clay loam in pots soon before they were forced to wilt by withholding the supply of water.

The leaves. At the first sign of wilting, plants were cut off from the base. Then, the leaf blade was separated from the leaf sheath. To obtain their fresh weights, the leaf blades and the leaf sheaths from each culture were weighed separately in an analytical balance. They were afterward wrapped separately in paper and placed in an electric oven at 100°C. to dry to constant weight.

Moisture determination. To determine the percentage of moisture content of the soil samples and of the samples of the leaves, the fresh weight of the sample minus the dry weight of the sample gave the moisture content in grams. The moisture content obtained was divided by the dry weight of the sample. It gave a quotient which, when multiplied by 100, gave the percentage of moisture in the sample.

RESULTS

The original data. The mass of original experimental data that was obtained from the ten culture trials (Trials I to X, inclusive) are given in appendix tables 1 to 10[2] inclusive. In these appendix tables are shown the dates when soil samples were taken at the beginning and while the leaves of the rice plants at the age of 30, 60, and 90 days were wilting. In these tables are also shown data on fresh weight of samples of soil, their dry weights, and their respective moisture contents, in grams and percentage. The average air temperature and the average relative humidity of the air during the period of a series of experiments are also given. These weather data were compiled from the weather records for the College of Agriculture gathered by the Department of Agricultural Botany during 1937 and the early part of 1938.

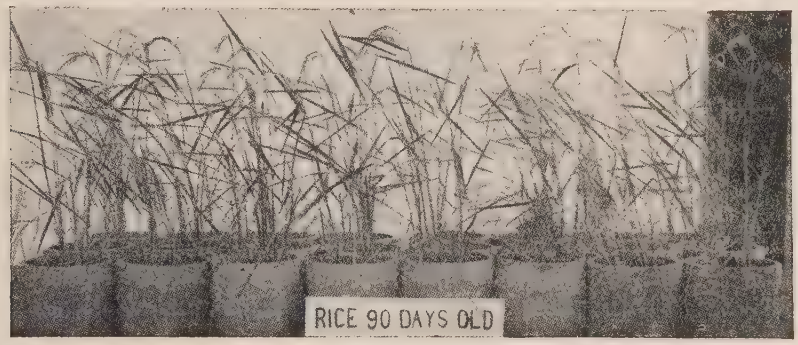

Fig. 3.—Rice plants, variety Inintiw, 90 days old, grown on clay loam in pots soon before they were forced to wilt by withholding the supply of water

To get an idea of the moisture contents of the leaf blades and of the leaf sheaths while they were wilting or already wilted and after soil samples had already been taken, data on these subjects were also gathered from some cultures. These additional data in per cent are shown in appendix tables 8 and 9.

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[2] This mass of experimental data is on file in the Department of Agricultural Botany.

Average moisture content. Similar data on moisture content of clay loam were averaged and the results are shown in table 1 for culture trials I, II, and III; in table 2 for culture trials IV, V, and VI; and in table 3 for culture trials VII to X inclusive. In these tables may also be seen the age of the plants, the dates when soil samples were taken, and data on air temperature and relative humidity of the air.

The average data on moisture content of the soil together with those on moisture content of leaf blades and leaf sheaths obtained from culture trials VIII and IX are given in table 4. Likewise the averages of similar data under each of the criteria employed, as well as data on air temperature and on relative humidity of the air are given in this table.

Table 5 shows the average of average moisture content of clay loam from the cultures that were conducted at different times. These data were compiled from tables 1, 2, and 3. To be able to correlate as data on air temperature and on relative humidity of the air are and the time of the year, additional pertinent data may also be seen in table 5.

DISCUSSION OF RESULTS

During the course of this study, it was observed that the leaves of the rice plant, variety Inintiw, grown on clay loam in pots, did not wilt at the same time. Some of the older leaves were already very much wilted; while the younger ones still looked rather fresh. Determination was made of the moisture content of clay loam at the time of wilting of the rice plants 30, 60, or 90 days of age. By the term *at the time of wilting* is here meant a period of about four or five days from the initial wilting of the leaves of the plant. During the later part of this period, the older leaves always became so wilted that they were rolled, pointed upward, and would not open again even when the potted plants were exposed for twenty-four hours to an almost water saturated atmosphere in a chamber. However, the small cluster of young leaves at the center of the crown still remained rather fresh and green in color.

Decrease of moisture content of clay loam during period of wilting

The data on moisture content of soil in tables 1, 2, and 3 for culture trials I to X inclusive, were for different stages of the wilting of the leaves of the plants. Under the conditions of this study, it took usually five days, sometimes only four days, from the initial wilting of most of the leaves before these became decidedly wilted. And the difference between the moisture content of the soil at initial wilting of most of the leaves and the moisture content of the soil when the leaves were sufficiently wilted was found quite variable, ranging from the biggest difference of 4.44 per cent to the least difference of 1.66 per cent. But as shown in tables 1, 2, and 3, the rates of decrease of moisture content of clay loam from day to day, although the soil in the pots was exposed to the atmosphere, were merely gradual and slight.

Changes of moisture content of leaf blade and leaf sheath during wilting

Table 4 shows the average results for culture trials VIII and IX. As was to be expected the moisture content of the soil decreased as the state of wilting of the leaves advanced. The moisture content of the leaf blades and of the leaf sheaths similarly decreased from day to day. In terms of average, their ratios in moisture content are shown in table A in per cent.

TABLE A

TRIAL NO.	PLANTS 30 DAYS OLD			PLANTS 60 DAYS OLD			PLANTS 90 DAYS OLD		
	Soil	Leaf blade	Leaf sheath	Soil	Leaf blade	Leaf sheath	Soil	Leaf blade	Leaf sheath
VIII	15.6	11.7	18.2	16.8	15.7	21.0	19.6	15.1	19.9
IX	14.5	14.1	19.6	22.0	13.8	20.4	22.9	14.0	19.8

In table A, no attempt is made to compare the data obtained for the plants of different ages because these data were obtained at different times. It will be seen that the ratios between the moisture content of the soil and those of the leaf blade and leaf sheath were not constant. Invariably the leaf blades became much drier than the leaf sheaths.

Moisture content of clay loam during wilting of leaves of rice plants 30, 60, and 90 days of age

Inspection of the data in table 5 shows that, owing to differences in dates, the data that were obtained from each culture trial for the 30, 60, and 90 days old rice plants are not comparable. In terms of average, however, comparison of the data for the three different ages of the plant became feasible. For example, the average moisture content of the soil during wilting of the leaves of the 30-day old plants was 18.04 per cent; that for the 60-day old plants, 20.02 per cent; and that for the 90-day old plants, 22.21 per cent. It, therefore, became evident that as the rice plants grew older, more and more moisture was left in clay loam in pots at the time of wilting. In other words, on the basis of the amount of moisture left in the clay loam soil, the older plants wilted earlier than did the younger plants.

Changes of moisture content of clay loam during wilting of leaves during the year

Table 5 shows that the moisture content of clay loam soil in pots during wilting of the leaves of the rice plants 30, 60, or 90 days of age varied from month to month, ranging in the case of the 30-day old plants from 20.38 per cent to 14.45 per cent. In the case of the 60-day old plants, the variation in the moisture content of the soil ranged from 22.2 per cent to 16.75 per cent. In the case of the 90-day old plants, the moisture content of the soil was higher, ranging from 24.57 per cent to 19.44 per cent. In other words, the amount of water that was left in clay loam soil at the time of wilting of the leaves seemed to vary with the time of the year, which, in turn, apparently was materially influenced by such conditions of the atmosphere as the temperature, relative humidity of the air, etc. A more detailed study of the data on the influence of certain factors of weather on wilting and on the amount of water left in the soil are discussed elsewhere.

Influence on wilting of leaves of rice by temperature of air as indicated by moisture contents of soil

In table 5 are also shown data on the average temperature of the air opposite the corresponding data on moisture content of the soil at the time of wilting. Examination of these data for the 30-day old rice plants, for the 60-day old plants, and for the 90-day old plants shows that, in a general way, the higher the temperature of the air the greater was the moisture content or the percentage of moisture that the plant could not extract from the clay loam soil before wilting. Conversely, the lower the air temperature, the lower was the moisture content of the soil. Thus it appeared that other conditions being equal, the greater the air temperature, the greater was the drying influence of the atmosphere. Such a condition, in turn, appeared to be responsible for the rather more rapid drying of the leaves of the rice plants, leaving behind in the soil a relatively greater moisture content unabsorbed by the roots of the plant and not evaporated into the atmosphere.

Influence on wilting of leaves by humidity of air as indicated by moisture in soil

Further examination of table 5 shows that it is possible to compare the data on moisture content of the soil at the time of wilting and the data on relative humidity of the air. Upon close scrutiny, it was revealed that no direct correlation existed, for, although in some instances high relative humidity of the air was accompanied by low moisture content of the soil, such relationship did not hold true in all cases. The converse was also true, that while some data on moisture content of the soil were obtained when the air had an apparently relatively low moisture content, other instances, showed no such relationship. Therefore, it could be concluded that the relatively humidity of the air appeared not to have had a very decisive influence in determining the amount of water that the roots of the rice plant failed to remove from the clay loam in pots.

Moisture content (by weight) of clay loam compared with percentage of saturation (by volume)

The data on moisture content here used are all expressed in percentage of the dry weight of the soil. To be able to determine their equivalent in percentage saturation (by volume), additional moisture determinations were made.

Clay loam was again used. The soil was sieved and mixed thoroughly. Then it was scattered on a concrete floor to dry in the air. When sufficiently dry, samples were taken and used for the determination of the moisture content of the soil. The result showed that the soil contained 9.08 per cent of moisture.

Then porcelain tumblers were filled with the soil, 500 grams each. The soil in one of these tumblers was saturated with water. The amount of water added was measured and found to be 232 milliliters. This amount of water and the amount of water originally present in the air-dry soil (500 g. × 9.08% = 45.4 g.) constitute the total amount present in the 100 per cent saturation, or 277.4 milliliters. The other percentages of saturation, 90, 80, 70, 60, 50, 45, 40, 35, 30, 25, and 20 were, one by one, computed and made up in the other tumblers on the basis of the 100 per cent saturation.

Samples in amounts shown in table 6, were taken from the different tumblers and their respective fresh weights were determined. These samples were dried in the electric oven to constant weight. From the data on fresh weights and those on the dry weights of the samples, the moisture content of the samples was computed. The results, in grams and in per cent, are shown in table 6. The data in the table that are of particular interest are those from 45 per cent saturation down to 20 per cent saturation and their respective equivalents in percentage of dry weight. By comparison of the data in table 6 with the per cent of moisture based on the dry weight of the soil, it becomes possible to determine the approximate equivalent, in per cent saturation, of the moisture content shown in tables 1 to 5 of the soil that was found at the time of wilting of the leaves of the rice plant.

SUMMARY AND CONCLUSIONS

1. The object of this study was to present data on moisture content of the soil at the time of wilting of the leaves of rice plants 30, 60, and 90 days of age.

2. It took usually five days, sometimes only four days, from the initial wilting of most of the leaves before these became decidedly wilted. The rates of decrease, day by day, of moisture content of clay loam grown to rice and exposed to air were gradual and slight.

3. The ratios between the moisture content of the soil and that of the leaf blade and leaf sheath were not constant. Invariably the leaf blades became drier than the leaf sheaths.

4. The average moisture content of the soil during wilting of the leaves of the 30-day old plants was 18.04 per cent; that for the 60-day old plants, 20.02 per cent; and that for the 90-day old plants, 22.21 per cent.

5. As the rice plants grew older, more and more moisture was left in clay loam at the time of wilting. On the basis of the amount of moisture left in the clay loam, the older plants wilted earlier than the younger plants.

6. The moisture content of clay loam in pots during wilting of the leaves of the rice plants varied from month to month. The amount of water that was left in clay loam at the time of wilting of the leaves seemed to vary with the time of the year.

7. In general, the higher the temperature of the air, the greater was the percentage of moisture that the plant could not extract from the soil before wilting. Conversely, the lower the air temperature, the lower was the moisture content of the soil.

8. The relative humidity of the air appeared not to have had a very decisive influence in determining the amount of water that the roots of the rice plant failed to remove from the clay loam in pots.

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TABLE 1

Average moisture contents of clay loam at the time of wilting of leaves of rice plants of different ages

TRIAL NO.	PLANTS 30 DAYS OLD		PLANTS 60 DAYS OLD		PLANTS 90 DAYS OLD	
	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil
		per cent		*per cent*		*per cent*
I	March 18 ..	21.20	April 17 ...	23.31	May 17	25.74
	" 19 ..	21.17	" 18 ...	22.43	" 18	24.04
	" 20 ..	19.75	" 19 ...	22.28	" 19	22.28
	" 21 ..	19.48	" 20 ...	20.28	" 20	22.09
	" 22 ..	18.89				
	Average .	20.09		22.09		23.53
	Av. air temperature 29.7°C.		Av. air temperature 32.9°C.		Av. air temperature 32.1°C.	
	Av. rel. humidity of air 55 per cent		Av. rel. humidity of air 43.6 per cent		Av. rel. humidity of air 49.6 per cent	
II	April 21 ...	22.37	May 21	24.23	June 24 ...	26.50
	" 22 ...	22.19	" 22	23.37	" 25 ...	25.69
	" 23 ...	19.60	" 23	22.04	" 26 ...	24.03
	" 24 ...	18.82	" 24	21.15	" 27 ...	22.06
	" 25 ...	18.05	" 25	20.23		
	Average .	20.20		22.20		24.57
	Av. air temperature 33.1°C.		Av. air temperature 33.0°C.		Av. air temperature 32.0°C.	
	Av. rel. humidity of air 40.5 per cent		Av. rel. humidity of air 46.8 per cent		Av. rel. humidity of air 48.4 per cent	
III	May 21	22.37	June 22 ...	22.99	July 26	24.19
	" 22	20.73	" 23 ...	22.89	" 27	23.71
	" 23	19.84	" 24 ...	22.04	" 28	22.08
	" 24	19.63	" 25 ...	20.97	" 29	22.50
	" 25	19.35	" 26 ...	20.35	" 30	21.87
	Average .	20.38		21.84		23.03
	Av. air temperature 33.1°C.		Av. air temperature 31.6°C.		Av. air temperature 30.0°C.	
	Av. rel. humidity of air 46.2 per cent		Av. rel. humidity of air 44.6 per cent		Av. rel. humidity of air 60 per cent	

TABLE 2

Average moisture contents of clay loam at the time of wilting of leaves of rice plants of different ages

TRIAL NO.	PLANTS 30 DAYS OLD		PLANTS 60 DAYS OLD		PLANTS 90 DAYS OLD	
	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil
		per cent		*per cent*		*per cent*
IV	June 7	21.35	July 10	21.53	August 7 ..	23.96
	" 8	20.05	" 11	21.21	" 8 ..	23.17
	" 9	20.07	" 12	20.83	" 9 ..	22.35
	" 10	19.49	" 13	19.51	" 10 ..	21.35
	" 11	19.11	" 14	18.87	" 11 ..	20.81
	Average .	20.01		20.39		22.32
	Av. air temperature 31.7°C.		Av. air temperature 29.7°C.		Av. air temperature 30.0°C.	
	Av. rel. humidity of air 58.7 per cent		Av. rel. humidity of air 63.7 per cent		Av. rel. humidity of air 58.7 per cent	
V	August 2 ..	17.50	September 2	19.63	October 1 ..	24.59
	" 3 ..	16.50	" 3	18.69	" 2 ..	23.95
	" 4 ..	16.24	" 4	18.05	" 3 ..	22.87
	" 5 ..	15.50	" 5	16.97	" 4 ..	22.53
	" 6 ..	15.18	" 6	16.27	" 5 ..	21.92
	Average .	16.80		18.23		23.17
	Av. air temperature 29.4°C.		Av. air temperature 28.8°C.		Av. air temperature 30.0°C.	
	Av. rel. humidity of air 58.4 per cent		Av. rel. humidity of air 71.7 per cent		Av. rel. humidity of air 61 per cent	
VI	September 25	16.53	October 26 .	19.48	November 24	22.84
	" 26	15.81	" 27 .	19.04	" 25	21.35
	" 27	15.64	" 28 .	18.54	" 26	19.51
	" 28	15.37	" 29 .	18.20	" 27	18.97
	" 29	14.77	" 30 .	17.23	" 28	18.50
	Average .	15.62		18.49		20.16
	Av. air temperature 29.4°C.		Av. air temperature 28.9°C.		Av. air temperature 29.0°C.	
	Av. rel. humidity of air 58.7 per cent		Av. rel. humidity of air 55.0 per cent		Av. rel. humidity of air 65.0 per cent	

TABLE 3

Average moisture contents of clay loam at the time of wilting of leaves of rice plants of different ages

TRIAL NO.	PLANTS 30 DAYS OLD		PLANTS 60 DAYS OLD		PLANTS 90 DAYS OLD	
	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil	Date sample taken	Moisture content of soil
		per cent		*per cent*		*per cent*
VII	October 27	18.05	November 27	18.69	December 20	20.59
	” 28	16.94	” 28	17.90	” 21	19.70
	” 29	15.78	” 29	17.57	” 22	19.42
	” 30	15.33	” 30	17.04	” 23	18.88
	” 31	14.84	December 1	16.24	” 24	18.65
	Average	16.11		17.48		19.44
	Av. air temperature 28.3°C. Av. rel. humidity of air 57.8 per cent		Av. air temperature 28.1°C. Av. rel. humidity of air 62.8 per cent		Av. air temperature 28.4°C. Av. rel. humidity of air 62 per cent	
VIII	November 3	17.48	December 4	18.57	January 3	20.43
	” 4	16.60	” 5	17.90	” 4	20.27
	” 5	15.59	” 6	17.06	” 5	19.69
	” 6	15.28	” 7	16.50	” 6	19.60
	” 7	14.81	” 8	15.48	” 7	18.87
	” 8	14.28	” 9	15.01	” 8	18.77
	Average	15.60		16.75		19.60
	Av. air temperature 28.2°C. Av. rel. humidity of air 68 per cent		Av. air temperature 27°C. Av. rel. humidity of air 69.8 per cent		Av. air temperature 27.9°C. Av. rel. humidity of air 52 per cent	
IX	January 10	15.45	February 11	22.78	March 9	23.98
	” 11	15.23	” 12	22.70	” 10	23.74
	” 12	14.61	” 13	22.44	” 11	22.94
	” 13	14.14	” 14	21.45	” 12	21.86
	” 14	13.46	” 15	20.45	” 13	21.78
	Average	14.45		21.90		22.86
	Av. air temperature 26.3°C. Av. rel. humidity of air 60 per cent		Av. air temperature 31°C Av. rel. humidity of air 45.5 per cent		Av. air temperature 30°C. Av. rel. humidity of air 44.7 per cent	
X	February 14	21.03	March 13	22.67	April 11	25.20
	” 15	20.64	” 14	21.72	” 12	24.06
	” 16	19.75	” 15	21.47	” 13	23.37
	” 17	19.43	” 16	20.48	” 14	21.76
	” 18	19.23	” 17	19.60	” 15	21.33
	Average	20.10		21.12		23.14
	Av. air temperature 30.9°C. Av. rel. humidity of air 44.9 per cent		Av. air temperature 30.5°C. Av. rel. humidity of air 47.9 per cent		Av. air temperature 32°C. Av. rel. humidity of air 45 per cent	

TABLE 4

Average moisture contents of clay loam at the time of wilting of leaves of rice plants of different ages together with moisture contents of leaf blades and leaf sheaths

TRIAL NO.	PLANTS 30 DAYS OLD				PLANTS 60 DAYS OLD				PLANTS 90 DAYS OLD			
	Date sample taken	Moisture content of soil	Moisture content		Date sample taken	Moisture content of soil	Moisture content		Date sample taken	Moisture content of soil	Moisture content	
			Leaf blade	Leaf sheath			Leaf blade	Leaf sheath			Leaf blade	Leaf sheath
	1937	*per cent*	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
VIII	November 3	17.48	12.41	18.63	December 4	18.57	18.14	21.74	January 3 .	20.43	17.00	21.72
	” 4	16.60	12.14	18.42	” 5	17.90	17.02	21.42	” 4 .	20.27	16.39	20.71
	” 5	15.59	11.87	18.29	” 6	17.06	15.78	21.40	” 5 .	19.69	15.75	19.57
	” 6	15.28	11.58	18.12	” 7	16.50	15.13	21.30	” 6 .	19.60	14.94	19.32
	” 7	14.41	11.30	18.01	” 8	15.48	14.64	20.23	” 7 .	18.87	13.20	19.24
	” 8	14.28	10.99	17.60	” 9	15.01	13.25	19.98	” 8 .	18.77	13.05	19.08
	Average .	15.60	11.71	18.17		16.75	15.66	21.01		19.60	15.05	19.94
	Av. air temperature 28.2°C. Av. rel. humidity of air 65 per cent				Av. air temperature 27°C. Av. rel. humidity of air 69.8 per cent				Av. air temperature 27.9°C. Av. rel. humidity of air 52 per cent			
IX	January 10	15.45	15.73	20.58	February 11	22.78	15.88	21.53	March 9 ..	23.98	15.47	21.30
	” 11	15.23	14.65	19.99	” 12	22.70	15.53	21.04	” 10 ..	23.74	14.75	20.28
	” 12	14.61	13.76	19.73	” 13	22.44	13.28	20.61	” 11 ..	22.94	14.00	19.59
	” 13	14.14	13.50	19.46	” 14	21.45	13.17	20.09	” 12 ..	21.86	13.32	19.17
	” 14	13.46	12.86	18.42	” 15	20.45	11.32	18.90	” 13 ..	21.78	12.61	18.48
	Average .	14.45	14.10	19.63		21.96	13.83	20.43		22.86	14.03	19.76
	Av. air temperature 26.3°C. Av. rel. humidity of air 60 per cent				Av. air temperature 31°C. Av. rel. humidity of air 45.5 per cent				Av. air temperature 30°C. Av. rel humidity of air 44.7 per cent			

TABLE 5

Average of average moisture contents of clay loam from cultures conducted at different times

(DATA COMPILED FROM TABLES 1, 2, AND 3)

TRIAL NO.	DATES WHEN SAMPLES WERE TAKEN	PLANTS 30 DAYS OLD			DATES WHEN SAMPLES WERE TAKEN	PLANTS 60 DAYS OLD			DATES WHEN SAMPLES WERE TAKEN	PLANTS 90 DAYS OLD		
		Moisture content of soil	Av. temp. of air	Av. relative humidity of air		Moisture content of soil	Av. temp. of air	Av. relative humidity of air		Moisture content of soil	Av. temp. of air	Av. relative humidity of air
	1937	*per cent*	*°C.*	*per cent*	*1937*	*per cent*	*°C.*	*per cent*	*1937*	*per cent*	*°C.*	*per cent*
I	March 18-22	20.09	29.7	55.0	April 17-20 .	22.07	32.9	43.6	May 17-20 ..	23.53	32.1	49.6
II	April 21-25 .	20.20	33.1	40.5	May 21-25 ..	22.20	33.0	46.8	June 24-27 ..	24.57	32.0	48.4
III	May 21-25 ..	20.38	33.1	46.2	June 22-26 .	21.84	31.6	44.6	July 26-30 ..	23.03	30.0	60.0
IV	June 7-11 ...	20.01	31.7	58.7	July 10-14 ..	20.39	29.7	63.7	August 7-11 .	22.32	30.0	58.7
V	August 2-6 .	16.80	29.4	58.4	Sept. 2-6 ...	17.93	28.8	71.7	Oct. 1-5	23.17	30.0	61.0
VI	Sept. 25-29 .	16.62	29.4	58.7	Oct. 20-30 ..	18.49	28.9	55.0	Nov. 24-28 ..	20.16	29.0	65.0
VII	Oct. 27-31 ..	16.11	28.3	57.8	Nov. 27-Dec. 1	17.48	28.1	62.8	Dec. 20-24 ..	19.44	28.4	62.0
VIII	Nov. 3-8	15.60	28.2	68.0	Dec. 4-9	16.75	27.0	69.8	Jan. 3-8/38 .	19.60	27.9	52.0
IX	Jan. 10-14/38	14.45	26.3	60.0	Feb. 11-15/38	21.90	31.0	45.5	March 9-13 .	22.86	30.0	44.7
X	Feb. 14-18 ..	20.10	30.9	44.9	March 13-17	21.12	30.5	47.9	April 11-15 .	23.40	32.0	45.0
	Average ..	18.04	30.01	54.82		20.02	30.15	55.14		22.21	30.14	54.74

TABLE 6

Showing relationship between moisture content of clay loam by volume (per cent saturation) and moisture content as ordinarily expressed, by weight

PER CENT SATURATION (BY VOLUME)	REPLICATION	FRESH WEIGHT OF SAMPLE	DRY WEIGHT OF SAMPLE	MOISTURE CONTENT OF SAMPLE		AVERAGE MOISTURE CONTENT (BY WEIGHT)
		grams	*grams*	*grams*	*per cent*	*per cent*
100	a	85.83	54.13	31.17	58.56	58.64
	b	85.40	53.80	31.16	58.73	
90	a	57.50	29.64	15.06	52.64	52.43
	b	49.00	24.95	13.03	52.23	
80	a	82.91	57.19	26.72	47.55	47.08
	b	63.85	43.85	20.00	46.61	
70	a	90.15	63.71	24.44	41.57	40.82
	b	60.37	44.15	18.01	40.08	
60	a	50.44	36.43	14.01	38.46	38.35
	b	47.28	34.70	13.07	38.25	
50	a	47.84	38.81	11.03	29.96	29.05
	b	42.89	33.43	9.41	28.14	
45	a	46.93	38.16	8.77	26.95	26.49
	b	47.38	38.20	9.18	26.03	
40	a	47.83	38.67	9.16	23.70	23.98
	b	47.96	38.61	9.37	24.27	
35	a	45.62	37.90	7.32	20.30	20.52
	b	54.99	37.29	7.72	20.67	
30	a	60.97	43.35	7.62	17.59	17.69
	b	49.18	41.75	7.43	17.80	
25	a	53.63	46.93	6.70	14.27	14.27
	b	51.59	45.16	6.43	14.26	
20	a	56.17	50.12	6.05	12.07	11.88
	b	53.11	47.59	5.52	11.60	

PHYSIOLOGICAL STUDIES ON POULTRY: II. SEXUAL DIFFERENTIATION IN THE ORGANS OF THE VISCERA OF MALE AND FEMALE LOS BAÑOS CANTONESE FOWLS [1]

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Although numerous studies have already been done on the hen (Hutt, 1933) information on the size of the different organs of the viscera of both male and female fowls are still limited. In order to add to the meager information on this subject, these studies were conducted. The observations were made in the poultry laboratory of the Department of Animal Husbandry, from April, 1932, to November, 1934.

Review of literature

Regarding the internal organs of a fowl, Kaupp (1918) reports that, in the hen of average size, the stomach (proventriculus) is about 1.62 inches (4.11 cm.) long and 0.8 inch (2.03 cm.) wide; the duodenum, 5 inches (12.70 cm.) long; and the caeca, 7.61 inches (19.33 cm.) long. He also reported that the average weight of the gizzard of an average sized hen was 0.215 pound (97.52 grams) when full, and 0.126 pound (57.15 grams) when empty; that of the liver, 35 grams; and that of the spleen, 0.005 pound (2.27 grams). The average weight of the testes of a 10-month old cockerel was reported to be 0.021 pound (9.52 grams).

Romanoff (1933) in his studies on the morphological aspects of sex differentiation among baby chicks, compared a large number of day old male and female White Leghorn chicks and reported the following average figures:

CHARACTERS	MALE	FEMALE
	cm.	*cm.*
Testis:		
Length	0.465	—
Width	0.168	—
Ovary (Left):		
Length	—	0.620
Width	—	0.313
Intestines	28.05	27.38
Caecum	3.42	3.54

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[1] Experiment Station contribution No. 1264.

Regarding the weight of some of the internal organs of day old chicks, Romanoff (1933) also gave the following data:

CHARACTERS	MALE	FEMALE
	gm.	*gm.*
Gizzard	2.043	2.022
Liver	1.142	1.175
Heart	0.362	0.334

Concluding his studies, Romanoff (1933) stated that, on the average, males are a little larger than females hatched from eggs of corresponding sizes. The length of intestines and the weight of the gizzard and the heart are also larger in the males than in the females, although the length of the caecum and the weight of the liver are slightly greater in females than in males.

PLAN OF THE STUDY

Los Baños Cantonese chickens reared under normal conditions were used in these studies. Observations were made at five different ages: at hatch and at the ages of two, four, six, and eight months. Twenty birds were used for each set of observation, 10 males and 10 females. Before observations were made, feed was withheld for at least twelve hours in order to reduce the contents of the enterons.

As the material was to be utilized in another study the birds were carefully bled and picked before they were finally dissected. In the dissection, the skin along the side was cut with a pair of scissors; and with a knife, incisions were made on both sides of the birds. Starting at the point of the keel bone, the knife was drawn along the sides cutting the flesh. When the ribs were exposed to view, the joints were cut with a pair of scissors, dividing the body into upper half, composed of the back, neck, and head; and lower, composed of the breast.

The intestines were first removed from the body and the rest of the internal organs were severed in the following order: heart, liver, gizzard, kidneys duodenum, pancreas, spleen, and lungs. The weight of each organ was taken. The small organs, as the spleen, heart, lungs, kidneys, pancreas, and all internal organs of the birds at hatch, were weighed in an analytical balance; the other weighings were on a "Cenco" balance.

RESULTS AND DISCUSSION

The results obtained in this study are given in tables 1 to 14.

Organs of digestion. Except in a few minor instances, the digestive tract of male Los Baños Cantonese fowls does not materially differ from that of the female. It was observed that it was only at the age of eight months when the proventriculus of the female was significantly longer than that of the male, 0.5 ± 0.175 centimeters; the differences at other ages were not significant. In weight, however, the proventriculus of the female was consistently greater than that of the male and the differences were all significant (see table 1). It is apparent that the gizzard has no relation to sex; the differences did not follow a regular trend (see table 2). Although the female had a consistently longer duodenum than the male, it was observed that the males had the heavier duodenum than the females (see table 3). No consistent differences were observed in the length of the small intestines. Except at the age of six months when the small intestines were heavier in the males than in the females, no significant differences were observed (see table 4). In the male the right caecum was observed to be consistently longer than the left, although the difference was not significant (see table 5). The females seem to have heavier caeca than the males at the ages of six and eight months. At younger ages, however, there was little difference, if any (see table 6). The females appear to have longer, but lighter, large intestines than the males (see table 7).

Accessory organs of digestion. No consistent difference was observed between the weight of the liver of the male and of the female Los Baños Cantonese fowls (see table 8). A similar tendency was observed in the length as well as in the weight of the pancreas (see table 9). No consistent difference was observed in the weight of the spleen (see table 10).

Circulatory organ (*Heart*). It was observed that up to two months of age, no differences were observed between the length of the heart of the males and that of the females. After that age, however, the males were observed to have a significantly longer heart than the females. There was a tendency for the heart of the male to be heavier than that of the female, although the differences at all ages studied were insignificant (see table 11).

Urinary organ (*Kidneys*). No consistent differences were found between the weight of the kidneys of the male and of the female Los Baños Cantonese fowls studied. At two and at eight months of age, the females were observed to have heavier kidneys than the males. The differences were, however, not significant. At four and at six months of age, the kidneys of the males were observed to be significantly heavier than those of the females (see table 12).

Respiratory organ (*Lungs*). It was observed that the lungs did not differ materially in weight in the male and female Los Baños Cantonese fowls. When the lobes were weighed separately, it was found that there was no difference in weight between the right and left lobes of the lungs (see table 13).

Reproductive organs. Except at hatch, both the left and the right testes were weighed at the different ages studied. From the figures obtained, it was observed that there were no significant differences between the weight of the right and that of the left testes. The left testis, however, was slightly heavier than the right, particularly at the age of eight months. These observations are in accord with those of Kaupp (1918) who reported that "the two [testes] in the same birds are usually of the same size, although one testicle may be slightly longer than the other" (see table 14).

Like the testes, the weight of the ovary was not determined at hatch. As in the case of the testes, it was observed that the increase in weight of the ovary from hatch to four months of age was very gradual. The increase in the weight of the ovaries from four to six months and from six to eight months of age was very sudden. This increase was to be expected because at six months of age the pullets were beginning to lay eggs; at eight months, they were all laying (see table 14).

SUMMARY AND CONCLUSIONS

Measurements of the organs of the viscera of male and female Los Baños Cantonese fowls were taken at hatch, and at the ages of two, four, six, and eight months. The data obtained are summarized as follows:

1. Except in a few minor instances, no material difference was observed between the organs of digestion of the male and the female. The female had a heavier proventriculus, longer but lighter duodena, and longer but lighter large intestines than the male.

2. No consistent differences were observed between the accessory organs of digestion of the male and of the female fowls.

3. It was observed that there was a tendency for the heart of the male fowl to be longer and heavier than that of the female.

4. No consistent differences were observed between the weight of the kidneys of the male and of the female fowls.

5. The lungs did not differ materially in weight in the male and in the female fowls. There was no difference in weight between the right and left lungs.

6. The left testis was observed to be slightly heavier than the right, although the difference between the two was not significant.

7. The increase in weight of both the testes and the ovary to four months of age was observed to be gradual; but from four to eight months, the increase in weight was very sudden.

8. At the age of eight months, the measurements of principal organs of the viscera of male and female fowls were observed to be as follows:

ORGANS	MALE	FEMALE
Gizzard, weight	46.2 ± 0.088 gm.	47.7 ± 0.289 gm.
Small intestine, length	102.7 ± 1.132 cm.	93.5 ± 2.230 cm.
Large intestine, length	10.4 ± 0.125 cm.	10.5 ± 0.067 cm.
Liver, weight	24.5 ± 0.624 gm.	27.8 ± 1.421 gm.
Spleen, weight	4.6 ± 0.046 gm.	4.2 ± 0.129 gm.
Heart, weight	6.6 ± 0.367 gm.	5.3 ± 0.282 gm.
Kidneys, weight	7.5 ± 0.112 gm.	8.6 ± 0.383 gm.
Lung, right lobe, weight	2.8 ± 0.112 gm.	2.8 ± 0.125 gm.
Lung, left lobe, weight	2.7 ± 0.138 gm.	2.7 ± 0.110 gm.
Reproductive organs:		
Testes, right, weight	6.6 ± 0.547 gm.	—
Testes, left, weight	8.2 ± 0.693 gm.	—
Ovary, weight	—	33.66 gm.

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TABLE 1

Length and weight of the proventriculus of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	1.4 ± 0.026	0.4 ± 0.009	1.7 ± 0.049	0.4 ± 0.007
Two months ...	2.4 ± 0.042	3.3 ± 0.183	2.5 ± 0.033	4.3 ± 0.034
Four " ...	2.8 ± 0.027	4.1 ± 0.127	2.9 ± 0.076	4.8 ± 0.185
Six " ...	3.9 ± 0.057	4.0 ± 0.144	4.3 ± 0.053	5.2 ± 0.079
Eight " ...	5.6 ± 0.102	5.1 ± 0.290	6.1 ± 0.015	6.3 ± 0.086

TABLE 2

Weight of the gizzard of male and female Los Baños Cantonese fowls

AGE	MALE	FEMALE
	gm.	*gm.*
At hatch	2.2 ± 0.067	2.1 ± 0.021
Two months	15.0 ± 0.557	15.1 ± 0.111
Four "	26.6 ± 1.040	30.5 ± 1.093
Six "	36.6 ± 0.265	32.7 ± 1.230
Eight "	46.2 ± 0.088	47.7 ± 0.289

TABLE 3

Length and weight of the duodenum of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	4.2 ± 0.189	0.2 ± 0.007	5.0 ± 0.086	0.2 ± 0.004
Two months ...	6.6 ± 0.154	6.2 ± 0.234	9.1 ± 0.105	6.1 ± 0.102
Four " ...	8.5 ± 0.064	7.9 ± 0.166	9.9 ± 0.225	7.3 ± 0.276
Six " ...	9.2 ± 0.035	13.1 ± 0.049	11.5 ± 0.346	9.2 ± 0.283
Eight " ...	10.6 ± 0.300	16.7 ± 0.121	12.6 ± 0.301	8.9 ± 0.541

TABLE 4

Length and weight of the small intestine of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	25.5 ± 0.371	0.4 ± 0.009	24.8 ± 0.474	0.4 ± 0.008
Two months ...	79.4 ± 1.302	14.9 ± 0.055	80.9 ± 0.780	14.9 ± 0.096
Four " ...	88.9 ± 0.593	18.5 ± 0.245	85.9 ± 3.737	18.5 ± 0.978
Six " ...	89.2 ± 0.440	35.7 ± 0.142	91.7 ± 1.589	27.9 ± 0.963
Eight " ...	102.7 ± 1.132	36.4 ± 0.386	93.5 ± 2.230	36.1 ± 0.805

TABLE 5

Length of the caeca of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Right	Left	Right	Left
	cm.	*cm.*	*cm.*	*cm.*
At hatch	3.4 ± 0.035	3.2 ± 0.017	3.3 ± 0.032	3.2 ± 0.029
Two months ...	10.2 ± 0.190	9.9 ± 0.178	10.0 ± 0.063	9.8 ± 0.029
Four " ...	11.2 ± 0.158	10.5 ± 0.170	12.9 ± 0.350	13.1 ± 0.254
Six " ...	12.9 ± 0.241	12.2 ± 0.150	13.3 ± 0.268	13.5 ± 0.161
Eight " ...	13.3 ± 0.200	13.2 ± 0.111	14.6 ± 0.442	14.8 ± 0.492

TABLE 6

Weight of the caeca of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Right	Left	Right	Left
	gm.	*gm.*	*gm.*	*gm.*
At hatch	0.2 ± 0.025	0.2 ± 0.013	0.2 ± 0.011	0.2 ± 0.002
Two months ...	1.6 ± 0.044	1.4 ± 0.067	1.2 ± 0.017	1.2 ± 0.025
Four " ...	2.2 ± 0.104	2.3 ± 0.089	2.1 ± 0.091	2.2 ± 0.090
Six " ...	3.4 ± 0.048	3.1 ± 0.025	3.6 ± 0.026	3.6 ± 0.056
Eight " ...	3.4 ± 0.046	3.4 ± 0.046	3.8 ± 0.034	4.0 ± 0.085

TABLE 7

Length and weight of large intestine of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	2.9 ± 0.088	0.07 ± 0.004	3.0 ± 0.083	0.08 ± 0.003
Two months ...	4.9 ± 0.102	2.0 ± 0.099	5.0 ± 0.086	1.6 ± 0.052
Four " ...	7.0 ± 0.118	2.4 ± 0.087	5.9 ± 0.302	2.3 ± 0.089
Six " ...	9.1 ± 0.070	3.4 ± 0.032	10.3 ± 0.283	2.3 ± 0.005
Eight " ...	10.4 ± 0.125	4.2 ± 0.004	10.5 ± 0.067	2.9 ± 0.013

TABLE 8

Weight of the liver of male and female Los Baños Cantonese fowls

AGE	MALE	FEMALE
	gm.	*gm.*
At hatch	1.1 ± 0.013	1.2 ± 0.028
Two months	9.4 ± 0.019	9.7 ± 0.142
Four "	22.3 ± 0.309	18.3 ± 0.986
Six "	24.1 ± 0.189	23.5 ± 0.591
Eight "	24.5 ± 0.624	27.8 ± 1.421

TABLE 9

Length and weight of the pancreas of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	2.6 ± 0.014	0.05 ± 0.002	2.6 ± 0.016	0.05 ± 0.009
Two months ...	6.7 ± 0.157	1.5 ± 0.032	7.1 ± 0.093	1.3 ± 0.029
Four " ...	9.1 ± 0.297	2.9 ± 0.044	8.1 ± 0.103	2.4 ± 0.064
Six " ...	9.0 ± 0.089	3.3 ± 0.046	8.4 ± 0.123	3.6 ± 0.062
Eight " ...	9.5 ± 0.054	5.4 ± 0.052	9.2 ± 0.226	5.3 ± 0.051

TABLE 10

Weight of the spleen of male and female Los Baños Cantonese fowls

AGE	MALE	FEMALE
	gm.	*gm.*
At hatch	0.004 ± 0.001	0.004 ± 0.001
Two months	1.0 ± 0.052	1.2 ± 0.026
Four "	2.7 ± 0.130	2.2 ± 0.152
Six "	3.3 ± 0.323	3.2 ± 0.263
Eight "	4.6 ± 0.046	4.2 ± 0.129

TABLE 11

Length and weight of the heart of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Length	Weight	Length	Weight
	cm.	*gm.*	*cm.*	*gm.*
At hatch	1.3 ± 0.018	0.3 ± 0.005	1.3 ± 0.022	0.4 ± 0.004
Two months	2.4 ± 0.030	2.2 ± 0.081	2.4 ± 0.044	2.1 ± 0.040
Four "	3.3 ± 0.026	3.0 ± 0.114	2.6 ± 0.051	2.9 ± 0.163
Six "	4.3 ± 0.061	3.6 ± 0.047	3.0 ± 0.081	3.8 ± 0.141
Eight "	5.3 ± 0.059	6.6 ± 0.367	3.6 ± 0.112	5.3 ± 0.282

TABLE 12

Weight of the kidneys of male and female Los Baños Cantonese fowls

AGE	MALE	FEMALE
	gm.	*gm.*
At hatch	0.4 ± 0.009	0.4 ± 0.009
Two months	3.3 ± 0.089	3.4 ± 0.047
Four "	6.5 ± 0.099	4.6 ± 0.194
Six "	6.6 ± 0.072	5.9 ± 0.205
Eight "	7.5 ± 0.112	8.6 ± 0.383

TABLE 13

Weight of the lung of male and female Los Baños Cantonese fowls

AGE	MALE		FEMALE	
	Right	Left	Right	Left
	cm.	*gm.*	*cm.*	*gm.*
At hatch	0.02 ± 0.002	0.03 ± 0.006	0.02 ± 0.001	0.02 ± 0.001
Two months ...	1.0 ± 0.057	1.1 ± 0.058	1.0 ± 0.032	1.0 ± 0.074
Four ” ...	1.8 ± 0.082	1.8 ± 0.089	1.7 ± 0.075	1.6 ± 0.075
Six ” ...	2.0 ± 0.080	1.9 ± 0.095	2.0 ± 0.122	1.9 ± 0.142
Eight ” ...	2.8 ± 0.112	2.7 ± 0.138	2.8 ± 0.125	2.7 ± 0.110

TABLE 14

The weight of the testes and the ovaries at two, four, six, and eight months of age

AGE	TESTES		OVARIES
	Right	Left	
	gm.	*gm.*	*gm.*
Two months	0.3 ± 0.012	0.4 ± 0.009	0.14
Eight ” ..	0.5 ± 0.011	0.5 ± 0.009	0.39
Six ” ..	1.2 ± 0.017	1.3 ± 0.035	27.45
Four ” ..	6.6 ± 0.547	8.2 ± 0.693	33.66

A STUDY OF FLORAL BIOLOGY AND BOLL SETTING OF COTTON[1]

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WITH ONE TEXT FIGURE

The maintenance of a pure stock of cotton may be done by proper care of the plants which serve as sources of seeds during the flowering period. This should be done especially when there is more than one variety planted in the field. In order to maintain a pure stock of desirable cotton varieties, unwanted cross-pollination should be minimized. The factors contributing to cross-pollination may be partly known by studying the floral behavior of cotton. Any result or observation on the behavior of cotton flowers would be of help in improving the culture of this crop.

Review of literature

Rate of square formation. The number of cotton bolls that mature depends on the rate of appearance of the squares. Martin, Ballard, and Simpson (1923) found that the appearance of the square always preceded the development of the internode on which it is borne. They also found that the rate of formation of fruits was approximately three days, with none of the varieties studied showing differences.

Abcission of flowers. The causes and percentages of abcission of cotton flowers vary according to varieties and localities in which cotton is grown. Dabney (1896) stated that the percentage of the number of bolls maturing ranged from 11 to 18. Buie (1928) found that under normal conditions, 50 per cent of the immature bolls shed. Brown (1927) reported that about 40 per cent of the flowers produced bolls.

Lloid (1920) found that the squares and flower buds were the most susceptible to shedding. The bolls do not shed after the tenth day unless wounded by insects or mechanical means.

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[1] Experiment Station contribution No. 1265.

Buie (1928) reported that the shedding of bolls occurs within 8 to 10 days after anthesis. Chakrabandhu[2] found that the average age of immature bolls of the plants grown from selfed seeds when they were shed from the reproductive branches ranged from 3 days in Pima I to 12 days in Giza 12. The immature bolls of the plants grown from unselfed seeds were shed at an average age of from 8 days in Giza 19 to 14 days in Giza 12.

Dutt (1928) reported that abcission of cotton flowers occurred at or near the base of the internode, but sometimes in the middle.

Harland (1929) stated that the shedding of young bolls and flowers resulted in the production of more buds at other points of active cell division. He explained that the food supply to be used by the lost bud or boll could be used by the fresh buds or bolls.

Viability of pollen. Cotton pollen is known to vary in viability. Kearney (1923) reported that the viability of the pollen of Pima Egyptian and of Durango (upland) cotton, as measured by the ejection of the cell contents when the grains were immersed in a sugar solution was low during the early hours of the morning, but began to increase rapidly between 8 and 9 a.m. and showed a gradual decline during mid-day. Inclosure of the flowers in a paper bag prolonged the period of viability.

Brown (1927) stated that the pollen grains are most viable at 10 a. m. and at from 2 p. m. to 6 p. m., only 3 to 4 per cent seems alive. The pollen grains remain normal up to 6 p. m., when the flowers are bagged.

Pollen-tube growth. The rate of growth of the pollen tube in the conducting tissues of the style is not very well known. Buchholz and Blakeslee (1926) found that the maximum rate of growth of cotton pollen-tube in the pistil is attained after about 2 hours from germination and from that time on the growth is uniform at a constant temperature of about 28.9°C.

Fertilization. The cotton flowers are either self- or cross-fertilized. The degree of self- or cross-fertilization and the length of time that fertilization takes place after anthesis were studied by some investigators whose names are mentioned elsewhere in this paper.

Balls (1912) and Brown (1927) found that fertilization was normally completed within 30 hours after the flowers had opened.

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[2] CHAKRABANDHU, M. C. A study of some of the important agronomic and morphological characters of cotton varieties grown from selfed and unselfed seeds. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Science in Agriculture. 1937. Unpublished.)

Robson (1912) observed that fertilization in the majority of cotton flowers was affected from the section of the stigma nearest the ovary.

Kearney (1923) stated that the degree of fertilization resulting from natural pollinations was found to differ in different seasons and at different times in the same season as well as in different localities.

Kearney (1924) found that pronounced selective fertilization occurs in the Egyptian type. This finding affords a satisfactory explanation of the fact that self-fertilization predominated in cotton, although the flowers are so admirably adapted to cross-pollination.

Fikry (1931) stated that the percentage of natural crossing fell to zero at a distance of 40 meters from the source of foreign pollen. The pollen grains fell off rgularly in all directions, indicating that the wind played little part.

Metaxenia. The length of lint of cotton shows variations. The discovery of Swingle (1928) and Nixon (1928) of metaxenia, or immediate effect of pollen on tissues of the mother plant, in the date palm, suggested the possibility that variations observed in cotton might in some cases result from the immediate effect of cross-fertilization.

Harrison (1931) in his study of metaxenia in cotton, observed its effects on the lint length. The reciprocal cross-pollinations of Pima Egyptian and Acala upland cottons resulted in a significant decrease of the lint length when Pima flowers were fertilized with Acala pollen and significantly increased when Acala flowers were fertilized with Pima pollen. In both cases, the difference, in comparison with the lint length from fertilization with like pollen, averaged slightly more than 1/16 of an inch (1.9 mm.)

Objects of the present work

The present investigation was undertaken with the following objects: (*a*) to study the biology of flowering and boll setting of some promising short- and long-staple cottons grown on the college farms, and (*b*) to record insect pollinators which enhance pollination.

Time and place of the work

The field observations were performed in the Experiment Station grounds, and the laboratory studies were done in the plant breeding division of the College of Agriculture from July, 1936, to February, 1938.

MATERIALS AND METHODS

Long- and short-staple cotton varieties were used in this study. These materials may be seen in table A.

TABLE A

Varieties of cotton used in this study

VARIETY	PLACE OF ORIGIN	DATE INTRODUCED
Long staple		
Giza 7	Cairo, Egypt	Obtained by Dr. E. P. Baltazar from the Ministry of Agriculture in 1935.
Giza 12	” ”	”
Giza 19	” ”	”
Pima II	U. S. Department of Agriculture	Obtained by Dr. E. P. Baltazar from the Plant Pest Division in 1935.
Pima I	”	Obtained by Dean B. M. Gonzalez in 1931.
Sea Islands	”	”
Short staple		
Batangas White	College of Agriculture	Seeds obtained from the Cotton Division, Department of Agronomy, College of Agriculture.
Black Bagley	Texas	Obtained by Dr. E. P. Baltazar from Dr. Goldsmith of the University of Texas in 1935.
Family A	”	”
Family U	”	”

These varieties were planted in November, 1936, and cultured under the supervision of the division of cotton and tobacco of the Department of Agronomy of the College.

Study of developmental period of floral bud or "square"

At the earliest sign of the appearance of the "square" all the available buds in each plant were tagged by being tied with a piece of string around the pedicel of each "square". After one week the tags were replaced by wooden labels. Records of (*a*) the date of the earliest appearance of squares, (*b*) anthesis, and (*c*) dehiscence of pollen were kept. Ten plants were studied in each of the ten varieties.

Floral structure

At anthesis, the floral parts were studied.

Pistillate parts. The following were measured: (1) the length of stigmatic surface (figure 1, *a*), (2) length of style (figure 1, *c*), (3) the length of ovary (figure 1, *d*), and (4) the total length of the

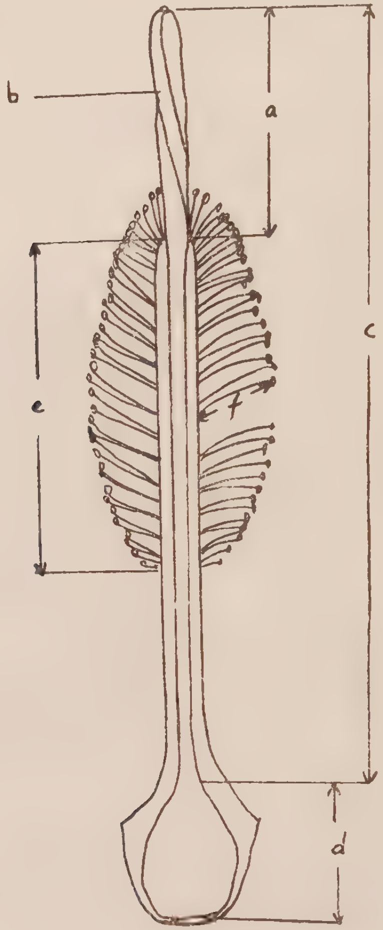

Fig. 1.—Diagramatic drawing of the essential parts of the flower studied: (*a*) stigmatic surface; (*b*) stigmatic lobe; (*c*) length of style; (*d*) length of ovary; (*e*) length of staminal tube covered by the stamens; (*f*) length of filament

staminal tube covered with stamens (figure 1, *e.*). The number of stigmatic lobes was also determined.

Staminate parts. (1) The length of filaments (figure 1, *f*) was measured in each flower at the time of dehiscence. (2) The stamens were removed one by one with fine-pointed forceps and the total number of stamens on the staminal tube was determined. (3) The abundance or scarcity of pollen grains on the anthers was also determined.

Age of maturity and life duration of pollen and stigma

The age of maturity of the pollen which covered the period from anthesis to its dehiscence was determined.

The period from anthesis up to the time the stigma became receptive, that is, when the mature pollen grains adhered easily to the stigmatic surface, was considered the age at which the stigma was mature.

The life duration of the stigma was determined by dusting pollen grains on it. When they did not stick on its surface, it was considered not receptive. The period lasting from the time the stigma became receptive to the time that it lost its receptivity was considered the life duration of the stigma.

The life duration of the pollen is from the time when the grains are dehisced up to the time they lose the power to germinate. This was tested by germinating pollen grains in an artificial culture medium adopted by Shibuya (1930). The culture medium consisted of from 35 per cent to 40 per cent sucrose plus 4 or 5 per cent agar agar. The pollen grains were germinated at one hour intervals from the time they were dehisced in the morning until five o'clock in the afternoon.

Pollination on premature stigma

Flowers supposed to open the following day were used in the study of pollination on premature stigma. The petals were opened slowly and then the stamens were all removed by fine-pointed forceps. They were removed carefully so as not to injure the stigma. Mature pollen grains from the same variety were then dusted on the stigmatic surface. The pollinated flowers were covered with white paper bags with small holes and were removed on the second day in order to expose the flowers to the sunlight and give them a chance to develop normally. Observation on the formation and shedding of bolls was made after the bags had been removed.

Abscission of flowers on each plant in a variety

One plant from every variety was selected and then marked by driving a peg at the base. The total number of bolls and flowers were counted at the start, and every three to four days, thereafter. The number of new flower buds, abcissed flowers, mature bolls, and the total number of existing flowers were recorded.

Test for parthenocarpy

By parthenocarpy is meant the development of fruits or bolls without the intervention of pollen grains.

The flowers which were to open the following day were emasculated. Care was exercised not to injure the stigma. The flowers were bagged immediately after emasculation. The white bags were punctured to allow free entrance of air and were removed after the second day when observations were made to find out whether bolls with seeds and lint were set or not.

Test for metaxenia, or immediate effect of pollen on the lint length

Batangas White, a short-staple variety, and Sea Island, a long-staple variety, were used in the study on metaxenia. The flowers of the Batangas White and Sea Island varieties, which were supposed to open the following day, were emasculated and bagged. The receptive stigmas of the Batangas White flowers were pollinated with the mature pollen of the Sea Island variety. The flowers of the Sea Island parent were bagged the day before the pollen grains were obtained. The cross-pollinated flowers were labeled. The bags were replaced after pollination and were removed the following day after pollination. Reciprocal crosses were made between Sea Island and Batangas White. The flowers of the parental varieties were bagged and were self-pollinated. As the bolls matured, they were harvested. The length of lint of both the parents and of the hybrids of the reciprocal crosses between the Batangas White and Sea Island was measured.

Growth of pollen-tube after pollination

The receptive stigmas were pollinated with mature pollen grains. Twelve and twenty-four hours later, the flowers were collected and brought to the laboratory. The staminal tube including the style was cut above the ovary. These were slit on both sides, and then scalded from 30 seconds to 2 minutes in hot water at a temperature ranging from 70° C. to 75° C. Killing and fixing was done by immersing them for from one to several hours in a solution of 50 per cent alcohol and 6 per cent formalin (Buchholz, 1931). Within 12 hours from the time that the material was put in the killing solution, the staminal tube was removed under a wide field binocular microscope. The style was then put in a watch glass, containing 8 parts of 1 per cent aqueous acid fuchsin and 2 parts of one per cent aqueous or alcoholic light green. The style was left there from three to six hours, or overnight if the stain was not concentrated. The stained style was cleaned several hours or overnight in 80 per cent lactic acid. It was then carefully spread on a clean slide. A cover glass was put on top, and with the aid of another slide, the specimen was pressed carefully until it spread without breaking the conducting tissues. A few days later, the preparation was sealed around the edges of the cover glass with damar in xylol. Diagrammatic drawings were made of the growth of the pollen-tubes under the high power objective of the microscope.

Insect pollinators

Observations of the insects that helped pollination of the flowers were made. The insects were collected after they were found to have really aided in the pollination of the cotton flower. The insects which were able to transfer the pollen grains from the anthers to the stigma, effecting either self- or cross-pollination through any part of their bodies such as the legs, and antennae, were considered pollinators of the flower. The insects collected were submitted to and identified by the Department of Entomology.

RESULTS AND DISCUSSION

Developmental period of floral buds or squares and maturity periods of the bolls

The square period, or the period between the date of appearance of the square and the date of flowering of the different varieties varied, as shown in table 1. The mean squaring period of the long-staple varieties ranged from 28.55 ± 0.14 days in Giza 19 to 32.39 ± 0.10 days in Sea Island. For the short-staple varieties, the range was from 19.79 ± 0.11 days in Batangas White to 22.10 ± 0.08 days in Family U. It will be noted from the figures mentioned above that the short-staple varieties set flowers earlier by about one to two weeks than the long-staple varieties.

The time of anthesis in the long-staple varieties ranged from around six to eleven o'clock a. m. and from about six to ten o'clock

a. m. in the short-staple varieties, with slight differences in all varieties. The dehiscence of pollen grains in the long-staple varieties occurred from 4 hours and 35 minutes to 5 hours and 41 minutes, while in the short-staple varieties, the range was from 4 hours and 14 minutes to 4 hours and 21 minutes. In no case did the flowers open in the afternoon. All opened and dehisced their pollen in the morning. It was observed that most of the flowers opened between 6 and 7 a. m.

It will be noted also that the age of maturity of the bolls for the long-staple varieties ranged from 41.70 ± 0.11 days in Giza 19 to 44.28 ± 0.13 days in Sea Island. For the short-staple varieties, the range was from 35.05 ± 0.13 days in family A to 39.28 ± 0.11 days in Batangas White. Based on the above figures, the short-staple varieties matured earlier than the long-staple by about two to nine days.

Measurements and counts of essential parts of cotton flower

It will be noted in table 2 that the length of stigmatic surface of the short-staple variety ranged from 0.79 ± 0.11 cm. in Family U to 1.12 ± 0.09 cm. in Batangas white. For the long-staple varieties, the length of stigmatic surface ranged from 0.89 ± 0.07 cm. in Pima I to 1.12 ± 0.13 cm. in Sea Island. The number of stigmatic lobes in both the short and long-staple varieties ranged from 2.80 ± 0.03 in Giza 7 to 3.28 ± 0.04 in Batangas White. The length of style of the long-staple varieties ranged from 2.50 ± 0.10 cm. in Pima II to 3.63 ± 0.16 cm. in Sea Island; and for the short-staple varieties the range was from 2.50 ± 0.19 cm. in Black Bagley to 2.84 ± 0.12 in Batangas White. The length of the ovary in both the short and long-staple varieties ranged from 0.70 ± 0.09 cm. in Family U to 0.85 ± 0.07 in Sea Island. The length covered by the stamens in both the short- and the long-staple varieties ranged from 1.44 ± 0.09 cm. in Pima II to 1.92 ± 0.12 cm. in Giza 7. Sea Island, in which the area covered by the stamens was 2.36 ± 0.07 cm., was an exception. The length of the filament in both the long and the short-staple varieties ranged from 0.40 ± 0.04 cm. in Giza 7 to 0.51 ± 0.04 cm. in Batangas White. The number of stamens of the long-staple varieties ranged from 104.26 ± 0.12 in Giza 19 to 134.62 ± 0.12 in Sea Island, whereas in the short-staple varieties, the range was from 94.02 ± 0.26 in Family U to 108.22 ± 0.16 in Batangas white, indicating that the long-staple varieties had slightly more stamens. In all varieties studied, the pollen grains were abundant.

Both the short- and long-staple varieties had about the same length of stigmatic surface, number of stigmatic lobes, length of ovary, length of staminal tube covered by stamens, length of filament, and abundance of pollen grains; but the long-staple varieties had slightly longer styles and a greater number of stamens.

Age of maturity and life duration of pollen and stigma

As shown in table 3, the stigma became receptive in from 3.08 ± 0.06 minutes for Pima I to 4.96 ± 0.11 minutes for Batangas White, whereas the age at maturity of the pollen ranged from 4.51 ± 0.12 for Giza 12 to 6.95 ± 0.12 for Batangas White. Based on the range in the age of maturity of the stigma and pollen, the stigma became receptive from about one to two minutes before anther dehiscence.

The stigma of all the varieties remained receptive for 9 to 10 hours after anthesis or about 3 to 4 p. m. of the same day, except in the case of Batangas White, in which the stigma was no longer receptive after 2 to 3 p. m.

The life duration of the pollen grains lasted until about two to three p. m., or about eight to nine hours after, except in the case of Batangas White, the pollen of which remained viable for from 7.5 to 8.5 hours after dehiscence. The difference in life duration of stigma and pollen of the Batangas White may be attributed to the exposure of these parts to the sun, which caused them to dry earlier because of the smaller size of petals compared with the other varieties. Banerjee (1929), however, reported that under natural conditions, a fairly high percentage of the pollen grains retain their viability 24 hours after their liberation from the microsporangium and lose their potency within the next 24 hours.

Premature pollination and parthenocarpy in cotton

As shown in tables 4 and 5, not a single boll developed as a result of either pollinating the stigma when this was still immature or allowing the emasculated stigma to develop without pollination. In the case of the pollinated immature stigma, the pollen grains might have lost their viability before the stigma became receptive. All of the treated flowers dropped soon after the bags had been removed.

It may be shown by the results of the emasculation of 825 flowers as presented in table 5 that the cotton flowers do not develop bolls without the intervention of the pollen. The 855 flowers (table 4) which were also emasculated but whose immature stigmas were pollinated also, supports the idea that the flowers of cotton are not parthenocarpic. The emasculated flowers dropped from the third up to the eighth day after emasculation. Balasubramaniam (1931) reported, however, that parthenogenesis might be present in cotton.

Abscission of flowers

The percentages of shedding of the flowers ranged from 70.78 per cent to 77.12 per cent in the long-staple varieties and 60.87 per cent to 77.56 per cent in the short-staple ones (table 6). Of all these studied, the Batangas White gave the highest percentage of matured bolls, which was 39.13 per cent, whereas Black Bagley gave the lowest, 22.44 per cent. Hammond (1896) reported a very low rate of abscission ranging from 11 to 23 per cent. The major causes here of shedding are the pests and diseases, although natural shedding also occurs. Kearney (1926) reported that there are some genetic factors responsible for shedding. The percentage of flowers that had abcissed directly affected the total production of bolls per plant. A higher percentage of abcission would certainly result in the production of a lower number of bolls.

Metaxenia, or immediate effect of pollen

The reciprocal cross-pollinations of the long- and short-staple varieties did not give significant differences in the length of lint (table 7). In the study of metaxenia in cotton by Harrison (1931), however, the difference of the mean length of lint of the parent and the hybrid bolls was 1.9 mm., which was significant.

Growth of pollen-tube after pollination

It was observed that the pollen-tube was not able to grow beyond the whole length of the style 12 hours after pollination. The pollen tube had covered the whole length of style twenty-four hours after pollination. Zaitzev (1925), in a special experiment, reported that the more active pollen-tubes had covered the whole length of the style (17 mm.) 10 hours after pollination. It was noted in this study that the pollen-tube had covered about ¾ of the style. This showed that the rate of growth during the first 12 hours was fast. Buchholz and Blakeslee (1926) found that there was a slight acceleration in the growth rate of the pollen-tube immediately after germination and the maximum rate was reached at about 2 hours after becoming uniform at constant temperature. The pollen-tube covered about ¾ of the length of the style 12 hours after pollination, and the whole length of the style 24 hours after.

Insect pollinators of cotton

The following insects were found to visit the cotton flowers and help either self- or cross pollination.

Amorphoidea lata Motschulsky of the family Curculionidae, commonly known as the Philippine boll-weevil, was found very abundant in blooming flowers. While going their way about in the flowers, their legs accumulate pollen grains which may be transferred to the stigma as they reach the stigmatic surface. It was observed that the newly opened flowers were pollinated soon after their presence in the flower.

Allodape marginata Smith of the family Apidae was found abundant in the open flowers. They feed on the petals and help pollination by carrying the pollen grains on their legs.

Phaneroptera furcifera Stål of the family Tettigoniidae had both the nymph and the adult feeding on the petals and they helped both self- and cross-pollination.

Trimenus sp. of the family Nitidulidae is a bee found to visit one flower after another. The pollen grains are carried by its hairy body or legs to the stigma of another flower or of the same flower. Unpollinated flowers were found pollinated after the insect had visited them.

Graptoblatta motulata (Ha-an) is a cockroach of the family Blattidae. They are found feeding on pollen grains. They help both self- and cross-pollination, but generally the former because they seldom go from one flower to another.

The small ants were attracted by the nectar secreted by the flower. They move fast here and there in the flower, usually causing self-pollination.

SUMMARY AND CONCLUSIONS

The results of the observations reported in this paper on floral biology of cotton involving long-staple varieties, such as, Giza 7, Giza 12, Giza 19, Pima I, Pima II, and Sea Island; and short-staple varieties represented by Batangas White, Black Bagley, Family A, and Family U may be summarized as follows:

1. The mean "squaring" period of the short-staple varieties was about one to two weeks earlier than the long-staple ones. The time it took the bolls of the long-staple varieties to mature from the time they were formed was longer by about two to nine days than the short-staple ones.

2. The short- and long-staple varieties had almost the same length of stigmatic surface, number of stigmatic lobes, length of the ovary, length of staminal tube covered by stamens, length of filament, and abundance of pollen grains; but the long-staple ones had a slightly longer style and a greater number of stamens.

3. The stigma matured earlier than the pollen by about one to two minutes, but the life duration of the pollen was about one hour shorter than the stigma. The latter had a life duration of from 9 to 10 hours after anthesis, while the pollen had a life duration of from 8 to 9 hours after anthesis.

4. Pollination on premature stigma did not result in the development of a boll.

5. The percentages of shedding of the flowers of all the varieties studied ranged from 60.87 to 77.80 per cent. Batangas White gave the highest percentage of mature bolls, 39.13.

6. The cotton flowers did not show parthenocarpic development of the bolls.

7. No immediate effect of pollen on the length of lint on the reciprocal crosses of the long- and short-staple varieties was found.

8. The pollen-tube was observed to reach the base of the style at about 24 hours after pollination.

9. The following insects were found visiting cotton flowers: *Allodape marginata* Smith, Family Apidae; *Amorphoidea lata* Motschulsky, family Curculionidae; *Phaneroptera furcifera* Stål, family Tettigoniidae; *Trimenus* sp., family Nitidulidae; *Graptoblatta notulata* (Ha-an), family Blattidae; and small ants whose identity could not be determined.

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TABLE 1

The periods of squaring, anthesis, dehiscence, and maturity of bolls of ten varieties

VARIETY	PLANTS USED	FLOWERS OBSERVED	MEAN "SQUARING" PERIOD	ANTHESIS	DEHISCENCE	AGE AT MATURITY OF BOLLS
	Number	*Number*	*days*	*a. m.*	*a. m.*	*days*
Long-staple						
Giza 7	10	105	31.46 ± 0.08	5:30 to 10:35	5:41 to 10:42	42.84 ± 0.12
Giza 12	10	108	30.17 ± 0.15	5:25 to 10:15	5:33 to 10:18	42.26 ± 0.02
Giza 19	10	109	28.55 ± 0.14	5:39 to 11:30	5:52 to 11:33	41.70 ± 0.11
Pima I	10	111	32.02 ± 0.07	5:45 to 10:32	6:02 to 10:37	43.35 ± 0.13
Pima II	10	104	31.71 ± 0.09	5:49 to 11:04	5:53 to 11:08	44.07 ± 0.16
Sea Island	10	113	32.39 ± 0.10	5:45 to 10:30	5:54 to 10:33	44.28 ± 0.13
Short-staple						
Batangas White	10	87	19.79 ± 0.11	5:50 to 10:15	5:58 to 10:02	39.28 ± 0.11
Black Bagley	10	64	20.55 ± 0.11	5:45 to 10:00	5:57 to 10:21	37.16 ± 0.13
Family A	10	52	20.75 ± 0.11	5:35 to 10:07	5:45 to 10:09	35.05 ± 0.13
Family U	10	56	22.10 ± 0.08	5:46 to 10:20	6:04 to 10:25	36.32 ± 0.12

TABLE 2

The statistical measurements of essential parts

VARIETY	LENGTH OF STIGMATIC SURFACE	STIGMATIC LOBES	LENGTH OF STYLE	LENGTH OF OVARY
Long-staple	*cm.*	*number*	*cm.*	*cm.*
Giza 7	0.97 ± 0.08	2.80 ± 0.03	3.48 ± 0.12	0.78 ± 0.06
Giza 12	1.02 ± 0.06	3.02 ± 0.01	3.53 ± 0.12	0.84 ± 0.06
Giza 19	0.97 ± 0.09	3.03 ± 0.04	2.71 ± 0.12	0.77 ± 0.06
Pima I	0.89 ± 0.07	2.97 ± 0.03	2.79 ± 0.16	0.76 ± 0.06
Pima II	0.92 ± 0.07	3.05 ± 0.03	2.50 ± 0.10	0.70 ± 0.04
Sea Island	1.12 ± 0.13	3.01 ± 0.03	3.63 ± 0.16	0.85 ± 0.07
Short-staple				
Batangas White	1.12 ± 0.09	3.28 ± 0.04	2.84 ± 0.12	0.80 ± 0.07
Black Bagley	0.93 ± 0.09	3.06 ± 0.05	2.50 ± 0.19	0.75 ± 0.09
Family A	0.84 ± 0.09	2.82 ± 0.05	2.83 ± 0.21	0.75 ± 0.09
Family U	0.79 ± 0.11	2.86 ± 0.05	2.71 ± 0.16	0.70 ± 0.09

TABLE 2 (continued)

VARIETY	LENGTH OF STAMINAL-TUBE COVERED BY STAMENS	LENGTH OF FILAMENTS	STAMENS PER FLOWER	ABUNDANCE OF POLLEN GRAINS
Long-staple	*cm.*	*cm.*	*number*	
Giza 7	1.92 ± 0.12	0.40 ± 0.04	123.72 ± 0.10	abundant
Giza 12	1.73 ± 0.10	0.49 ± 0.04	125.37 ± 0.18	abundant
Giza 19	1.68 ± 0.12	0.49 ± 0.07	104.26 ± 0.12	abundant
Pima I	1.61 ± 0.10	0.46 ± 0.04	128.22 ± 0.08	abundant
Pima II	1.44 ± 0.09	0.48 ± 0.01	123.34 ± 0.05	abundant
Sea Island	2.36 ± 0.07	0.47 ± 0.02	134.62 ± 0.12	abundant
Short-staple				
Batangas White	1.77 ± 0.11	0.51 ± 0.04	108.22 ± 0.16	abundant
Black Bagley	1.75 ± 0.16	0.47 ± 0.12	96.66 ± 0.24	abundant
Family A	1.66 ± 0.15	0.48 ± 0.06	98.84 ± 0.16	abundant
Family U	1.52 ± 0.14	0.43 ± 0.83	94.02 ± 0.26	abundant

TABLE 3

The relative period of maturity and life duration of stamens and stigma

VARIETY	AGE AT MATURITY OF STIGMA	LIFE DURATION OF STIGMA	AGE AT MATURITY OF POLLENS	LIFE DURATION OF POLLEN
	minutes	*hours*	*minutes*	*hours*
Giza 7	3.41 ± 0.10	9 to 10	4.77 ± 0.10	8 to 9 (2-3 p.m.)
Giza 12	3.27 ± 0.10	9 to 10	4.51 ± 0.12	8 to 9
Giza 19	3.20 ± 0.09	9 to 10	4.65 ± 0.09	8 to 9
Pima I	3.08 ± 0.06	9 to 10	5.30 ± 0.10	8 to 9
Pima II	3.56 ± 0.09	9 to 10	4.93 ± 0.07	8 to 9
Sea Island	3.98 ± 0.08	9 to 10	5.59 ± 0.09	8 to 9
Batangas White	4.96 ± 0.11	8 to 9	6.95 ± 0.12	7.5 to 8.5

TABLE 4

Pollination of premature stigma

DATE EMASCULATED AND POLLINATED	FLOWERS EMASCULATED										DATE WHEN FLOWERS DROPPED	BOLLS MATURED
	Giza 7	Giza 12	Giza 19	Pima I	Pima II	Sea Island	Batangas White	Black Bagley	Family A	Family U		
	number	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*		*number*
April 1, 1937	10			20		20	25				April 4 to April 8	None
2	15			15		20	20				” 5 ” ” 10	”
3		30			35						” 6 ” ” 11	”
15			25					20	15	15	” 18 ” ” 22	”
30			30					20	10	10	May 2 ” May 7	”
May 1		20			15	15	15				” 3 ” ” 8	”
2		20			20	20	10				” 4 ” ” 9	”
8		15			15	20	15				” 11 ” ” 16	”
24	20			25		15					” 27 ” ” 30	”
26	25			25		15					” 29 ” June 3	”
27		25	20		25						” 30 ” ” 4	”
29		25	20		30						June 2 ” ” 6	”
Total	70	135	95	85	140	125	115	40	35	25		None

Total number of flowers of all varieties emasculated—855

TABLE 5

Test for parthenocarpy

DATE EMASCULATED	FLOWERS EMASCULATED							DATE WHEN FLOWERS DROPPED	BOLLS MATURED
	Giza 7	Giza 12	Giza 19	Pima I	Pima II	Sea Island	Batangas White		
	number	*number*	*number*	*number*	*number*	*number*	*number*		*number*
May 6, 1937	—	—	—	30	—	—	—	May 9 to May 14	None
" 7	—	—	—	—	—	—	30	" 9 to " 15	"
" 8	—	—	—	—	—	20	—	" 11 to " 16	"
" 10	15	—	—	—	—	—	—	" 13 to " 18	"
" 13	—	—	20	—	—	—	—	" 16 to " 21	"
" 15	—	—	—	—	20	—	—	" 18 to " 23	"
" 16	—	25	—	—	—	—	—	" 19 to " 24	"
June 5	10	10	10	10	10	10	10	June 8 to June 13	"
" 12	15	15	15	10	10	15	10	" 15 to " 21	"
" 19	15	15	15	15	15	15	10	" 22 to " 27	"
" 26	15	15	15	15	15	15	10	" 29 to " 4	"
July 5	10	10	10	10	10	10	10	July 8 to July 13	"
" 17	10	10	10	10	10	10	10	" 20 to " 25	"
Aug. 13	10	10	10	10	10	10	10	Aug. 16 to Aug. 21	"
" 14	15	15	10	15	15	15	10	" 16 to " 22	"
Total	115	125	115	125	115	120	110		

Total number of flowers of all varieties emasculated—825

TABLE 6

The abcission of flowers of the ten cotton varieties

VARIETY	NUMBER OF	NEW "SQUARES' FORMED	BOLLS MATURED	"SQUARES" BOLLS	TOTAL FLOWERS	PERCENTAGE OF	
						Boils matured	Shedding
	days	*number*	*number*	*number*	*number*	*per cent*	*per cent*
Long-staple							
Giza 7	153	149	66	209	275	24.00	76.00
Giza 12	153	107	58	192	250	23.20	76.80
Giza 19	153	145	46	155	201	22.88	77.12
Pima I	153	150	71	210	281	25.62	74.38
Pima II	153	104	67	291	258	26.36	73.64
Sea Island	153	161	83	201	284	29.22	70.78
Short-staple							
Batangas White	107	73	45	70	115	39.13	60.87
Black Bagley	107	49	20	69	69	22.44	77.56
Family A	107	41	15	46	61	24.59	75.41
Family U	107	30	12	35	47	25.52	74.48

TABLE 7

The immediate effect of pollen or metaxenia on the length of lint

VARIETY	BOLLS	MEAN LENGTH OF LINT	DIFFERENCE
	number	*cm.*	
Batangas White (parent) (Short-staple)	50	3.22 ± 0.13	—
Batangas White (male) × Sea Island (female)	27	3.42 ± 0.15	0.20 ± 0.15
Sea Islands (parent) (Long-staple)	50	3.93 ± 0.10	—
Sea Island (female) × Batangas White (male)	54	3.72 ± 0.11	0.19 ± 0.20

A FURTHER STUDY OF CORN AND FRESH COCONUT MEAT AS FEED FOR GROWING AND FATTENING PIGS[1]

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The coconut industry is one of the oldest and most important in the Philippines. Recent legislation on the exportation of coconut products to the United States has affected adversely the future of the industry. One way to help stabilize the industry is to increase the uses of coconut products. Feeding coconut meat to hogs in times of abundance and depressed market may be of some help. Feeding fresh coconut meat to hogs at this College was first tried by Anselmo P. Afalla[2] in 1934, with encouraging results.

The present paper reports results of further work on feeding fresh coconut meat to hogs.

Review of literature

Father Francisco Alzina[3] in 1668, stated that "Grated or sliced coconut meat fattens hogs, and it has been found that with two hundred nuts freely accessible to the animals, the hogs get so fat that later on one hog would hardly eat half a nut a day. They eat the meat and on account of its oily nature they have to supplement the ration with leaves and other fruits".

Afalla in 1934, in his study on the feeding value of grated fresh coconut meat compared to corn, found that the pigs on the coconut ration (where one part of corn by weight was replaced by two parts of coconut meat) gained 82 per cent more in weight than the pigs on the corn ration. In feed consumption per unit of gain, the coconut ration was 25 per cent more efficient than the corn ration.

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[1] Experiment Station contribution No. 1266.

[2] AFALLA, A. P. 1938. A study of fresh coconut meat as a feed for growing and fattening pigs. The Philippine Agriculturist 26: 680–687.

[3] ALZINA, F. I. 1668. On the palms which are called cocos and their great usefulness. The Philippine Agriculturist 20: 435–446. 1931. (*Translated by* L. B. Uichanco.)

Object of the present work

The object of this study was to compare the feeding value of fresh coconut meat with corn in rations for growing and fattening pigs.

Time and place of the work

The experiment was begun on February 15, 1936, and concluded on September 11, 1936, a period of 210 days. It was divided into three 70-day periods. The work was conducted in the Department of Animal Husbandry, College of Agriculture, University of the Philippines, Los Baños, Laguna.

MATERIALS

Animals used. Eighteen grade weanling pigs about two months old were used in this study. The average weight of these pigs, which had been bought in Calamba, Laguna, was 5.58 kilograms per pig.

Feeds used. The feeds used were rice bran, copra meal, fish meal, corn, and fresh coconut meat. To every 100 kilograms of feed mixture, two kilograms of a mineral mixture consisting of equal parts common salt and charcoal were added.

Nature of the feed under study. The average weight of the nuts used was 1,203 grams each. The husk constituted 36.5 per cent of the total weight of the nut; shell and water, 37.8 per cent; and coconut meat, 25.7 per cent. Thus each nut yielded on an average 309 grams of meat.

METHODS

Allotment of pigs. The pigs were divided into three lots of six pigs each. Lot I pigs were given the standard corn ration; Lot II, the grated coconut ration; and Lot III, the ungrated coconut ration.

Preparation of fresh coconut meat. The grated coconut meat was prepared with the use of a common coconut grater. In the case of ungrated coconut the husked nut, after being cut into halves, was cracked into pieces by a wooden pestle. The size of the broken pieces of coconut meat was about three to four square centimeters. The meat prepared was then added to the other ingredients of the ration. To prevent it from becoming rancid only enough coconut meat was prepared for two feedings.

Analyses of the feeds compared. The following is the chemical composition[4] of the two feeds under comparison:

	MOISTURE	ASH	PROTEIN	CRUDE FIBER	CARBOHYDRATES	FAT	CALORIES	NUTRITIVE RATIO [a]
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*		
Corn	13.53	1.57	7.47	1.63	74.55	1.25	341	1:10.4
Coconut meat.	48.84	1.01	4.25	4.63	3.79	37.48	381	1:19.6

[a] Ratio of protein to carbohydrates and fats based on chemical analysis.

Ration mixture used. The proportion by weight of the ration used was varied as the animals grew older, thus:

PERIOD	FIRST 70-DAY			SECOND 70-DAY			THIRD 70-DAY		
Lots	I	II	III	I	II	III	I	II	III
Corn, cracked	15	0	0	20	0	0	25	0	0
Grated coconut	0	15	0	0	20	0	0	25	0
Ungrated coconut	0	0	15	0	0	20	0	0	25
Rice bran	60	60	60	60	60	60	60	60	60
Copra meal	15	15	15	15	15	15	13	13	13
Fish meal	10	10	10	5	5	5	2	2	2

The ratio of protein to carbohydrates and fats based on chemical analysis of the different rations used were:

RATION	LOT I	LOT II AND III
First 70-day period	1:4.0	1:5.5
Second 70-day period	1:4.5	1:6.5
Third 70-day period	1:5.0	1:7.5

The average prices of feeds used during the time of the investigation are as follows:

FEEDS	UNIT	PRICES	WT. IN KGM.	COST PER KGM.
Corn	cavan	₱ 2.60	58.0	₱0.045
Fresh coconut meat	100 nuts	1.64	30.9	0.053
Rice bran	cavan	1.18	25.0	0.047
Copra meal	ton	31.00	1000.0	0.031
Fish meal	ton	101.00	1000.0	0.101

The cost of grinding the corn, husking the coconut, and preparing the coconut meat was not included in the prices given above.

Feeding. The pigs were hand-fed twice a day between 6:00 and 7:00 a. m. and between 4:00 and 5:00 p. m. Enough of the feed was given to satisfy the pigs fully.

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[4] Analyzed by the Department of Agricultural Chemistry.

Weighing. The initial and final weights of the pigs were taken. During the test, weekly weighings were made before feeding.

Care and management. At feeding time, the three lots of pigs were fed separately in their respective pens. All the pigs had access to a field of second growth sweet potato between feeding times during the first seventy-day period. During the last two seventy-day periods, however, the animals were allowed a range on paddocks bare of vegetation. During the second seventy-day period, camote soilage to the extent of one per cent of the live weight was furnished. During the third, or last seventy-day period, no soilage was given. Summarizing the system of management, during the first seventy-day period which corresponded to the growing stage, the pigs were subjected to the grain-pasture system of feeding; during the second seventy-day period or the growth-fattening stage, to the grain-soilage system; and during the third seventy-day period, to the dry lot system. Depending upon weather conditions, they were bathed once or twice a day between feeding times.

RESULTS

The results of the partial and whole feeding trials are as follows:

	LOT I	LOT II	LOT III
First seventy-day period			
Average daily gain per pig (kgm.)	0.21	0.23	0.20
Feed consumed per kgm. gain (kgm.)	2.67	2.39	2.65
Feed cost per kgm. gain (centavos)	11	12	13
Second seventy-day period			
Average daily gain per pig (kgm.)	0.36	0.43	0.36
Feed consumed per kgm. gain (kgm.)	3.97	3.21	3.69
Feed cost per kgm. gain (centavos)	18	19	21
Third seventy-day period			
Average daily gain per pig (kgm.)	0.38	0.37	0.38
Feed consumed per kgm. gain (kgm.)	5.31	5.43	5.21
Feed cost per kgm. gain (centavos)	24	26	25
Whole 210-day period			
Average initial weight per pig (kgm.)	5.58	5.59	5.58
Average final weight per pig (kgm.)	72.28	77.66	71.70
Average daily gain per pig (kgm.)	0.32	0.34	0.32
Feed consumed per kgm. gain (kgm.)	4.15	3.85	4.00
Feed cost per kgm. gain (centavos)	17	19	20

DISCUSSION OF RESULTS

First seventy-day period. When treated statistically, the differences in the average daily gain per pig between the lots were found to be insignificant. The results show that corn and fresh coconut meat, weight for weight, are about equal in feeding value. The low feed cost in the corn lot was largely due to the fact that corn cost slightly less than an equivalent weight of coconut meat.

Second seventy-day period. The results obtained in this period were similar in tendency to those obtained in the first feeding period.

Third seventy-day period. During this period, lot II which gave good results during the first two feeding periods had poorer gains than those of the other two lots, although the difference was not significant.

Whole 210-day period. The results obtained during the whole 210-day feeding test showed that in rate of gain, lots I and III were about the same, whereas lot II appeared to be superior to both. When treated statistically, however, the differences were insignificant. Lot II made an average daily gain per pig of 0.34 kgm., while lots I and III each made 0.32 kgm.; the higher rate of gain of lot II pigs was not marked. Expressed in percentage, lot II was 6 per cent more efficient than lots I and III. In the amount of feed consumed per unit gain, lot II consumed the least, lots I and III consumed more. The difference between lots I and II was slight, although lot I consumed more feed. Using lot I as a basis for comparison, lot II was 8 per cent and lot III 4 per cent more efficient than the control lot.

Based on chemical analysis, the coconut ration has a wider ratio of carbohydrates and fats to protein than the corn ration. Fresh coconut meat also contained as much as 49 per cent moisture, while corn contained only 14 per cent. In spite of these defects, the young pigs fed grated coconuts gained more rapidly than the corn-fed pigs. These results corroborate substantially the findings of Afalla (1934).

Undoubtedly much labor is necessary to prepare grated coconut. Because of this, the relative labor cost of preparing corn, grated, and ungrated coconut was determined for purposes of comparison.

It was found that at the rate of 10 centavos per hour of labor, one hundred kilograms of cracked corn costs, on an average, ₱0.68 to prepare. This cost includes husking, shelling with a corn sheller, and cracking or grinding with a corn grinder, all operated by hand. The average cost of preparing grated coconut meat was ₱2.07 a hundred kilograms, and of ungrated coconut meat, ₱0.94. In the preparation of coconut, the cost of husking was included. It is clear that grated coconut is the most expensive to prepare; ungrated coconut, next; and cracked corn, the cheapest.

When the cost of preparation was added to the feed cost per kilogram gain during the 210-day period on the basis of corn or coconut constituting, on an average, 20 per cent of the ration, the feed for lot I will cost 17.01 centavos; lot II, 19.02 centavos; and lot III, 20.01 centavos. On the basis of the foregoing data, lot II compared with lot I is 89.4 per cent efficient, and lot III, 85.0 per cent.

It follows that at the rate of ₱1.64 a hundred coconuts, on which price the present work was based, and corn at ₱2.60 per cavan, the price of coconuts, will have to be reduced to ₱1.47 a hundred nuts in lot II, and ₱1.39 in lot III to equal lot I in cost of producing gains.

SUMMARY AND CONCLUSIONS

1. Based on rate of gain, cracked coconut meat has a feeding value equal to corn, weight for weight, for growing and fattening pigs. Grated coconut was 6 per cent more efficient than either cracked coconut or corn.
2. To produce a unit of gain, grated coconut was 8 per cent, and ungrated coconut 4 per cent, more efficient than corn.
3. In feed cost per unit of gain, at the prices prevailing at the time of this experiment, grated coconut was 89.53 per cent as efficient as corn, and ungrated coconut, 85 per cent. When the cost of preparation was included, grated coconut was 89.38 per cent, and ungrated coconut, 84.95 per cent as efficient as corn. To equal corn at ₱2.60 per cavan in cost of producing gains, the price of coconut, if given in grated form, should go down to ₱1.47, and if given ungrated, to ₱1.39 per hundred.

COST OF PRODUCING CASSAVA IN THE COLLEGE OF AGRICULTURE AT LOS BAÑOS[1]

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The production of cassava and the manufacture of starch and flour from its roots are becoming important industries in the Philippines. Numerous inquiries are being received in the College regarding the cost of production of this crop and the cost of each operation involved in its culture.

The heavy importation of wheat flour which can be partially substituted with cassava flour and the importation of cassava starch should stimulate the development of the cassava industry in the Islands. From 1928 to 1935, inclusive, the average annual importation of cassava starch was 5,158,636 kilograms valued at ₱601,786.00. The average annual importation of wheat flour during the same period was valued at ₱7,059,631.00.[2]

Cassava is grown in the Philippines not only as a source of starch and flour but also as a substitute for rice and as livestock feed. Gaplek[3] is used in the manufacture of cheap industrial alcohol.

This study was undertaken to determine, (1) the labor required for each operation in the production of cassava, (2) the total cost of production per hectare of the crop, (3) the yield of the crop, and (4) the cost of production per kilogram of roots.

The work was conducted in the Experiment Station field of the College of Agriculture from June, 1932, to December, 1937.

MATERIALS AND METHODS

Varieties of cassava

The varieties of cassava used in this work were Aipen Valenca, Kapo White, Mandioca Basiorao, Mandioca Tapicuru, seedling No. 2152, and Mandioca Sao Pedro Preto. The first four varieties are

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[1] Experiment Station contribution No. 1267. Received for publication September 8, 1938.

[2] Annual Reports of the Insular Collector of the Philippine Bureau of Customs for the years 1928 to 1935.

[3] "Gaplek" is a Malay word used to designate sliced peeled roots of cassava.

not poisonous but the Mandioca Sao Pedro Preto, according to Mendiola (1931), is very poisonous and not edible. This variety, however, is a high yielder both in roots and starch.

The planting materials were all secured from the Department of Agronomy of this College.

Fields and soil

A total area of 58,625 square meters was used in the work. Previous to the planting of cassava, the fields were either planted to corn or upland rice. The soil in these fields is clay loam.

Implements

Tractor. A Standard Fordson tractor, model 1929, was used in plowing. This tractor develops approximately 8 to 10 horse power at the drawbar. Gasoline is used as starting fuel and kerosene for field operations.

Disc plow. Pulled by the tractor, an Oliver No. 42 disc plow was used during the first plowing. It has two discs 61 centimeters in diameter. It is mounted on three wheels and has a lifting mechanism which can raise the plow at the furrow ends while making the turn.

J. D. Black Lead moldboard plow. This plow was used in plowing up the roots. It is of the general purpose type and can cut a furrow 18 centimeters wide. It has a big clearance which prevents the crowding of the roots at the throat, thus diminishing the danger of breaking them. Two animals were required to pull it.

Native plow. The native plow of the upland type was used for plowing, furrowing, and cultivation of the field. This plow is of heavier construction than that of the lowland type. It has a wooden beam and cast iron moldboard and share. It cuts a furrow approximately 11 centimeters wide. The average weight of this plow is 17.5 kilograms.

Native bamboo harrow (calmot). For harrowing the field, the *calmot* was used. It is made of twelve bamboo stubs one meter long fastened together by two long pegs.

CULTURAL OPERATIONS

Preparation of land

During the period covered by this study, the land was plowed early in the month of May. The first plowing was done with a Fordson tractor and a disc plow. It was found necessary to plow the land first with this outfit in order to secure the necessary depth of about 20 centimeters. In order for this depth to be secured with the native plow, it would have taken at least two plowings. The second plowing was done with the native plow about two weeks after the first. Each plowing was followed by thorough harrowing with the *calmot*. Furrows of about 20 centimeters deep were laid one meter apart with the native plow just before planting.

Planting

Cassava stems of age ranging from 12 to 14 months were cut into 25 centimeter pieces, excluding the green young portions on top. A man dropped the cuttings in the furrow one at a time in a horizontal position and at a distance ranging from 75 centimeters to one meter apart. Another man followed the first who covered the seed pieces with soil. During the five-year period covered by this study, all plantings were done in the months of June and July.

Cultivation and weeding

The first cultivation took place about one and a half months after planting. The spaces between the rows were plowed with the native plow. One month later it was followed by the second cultivation which was the hilling-up. The field was weeded with the native sickle before and after each cultivation. No more cultivation was done after the hilling-up operation to avoid danger of injuring the young roots which were in the process of development. By this time the plants were about one meter high, with their leaves forming a dense shade, thus preventing a thick growth of weeds.

Harvesting

The stems of the plants were cut close to the ground and removed from the field. The roots were then plowed up with the J. D. Black Lead moldboard plow pulled by two bullocks. One man guided the team while another handled the plow. When the soil was hard, the rows were plowed three times. The first two trips of the plow ran once at each side of the row in opposite directions, throwing the soil away from it. The third trip of the plow ran right through the center of the row which plowed up the whole root system. The roots thus plowed up were collected and piled to prevent covering them with the soil from the next furrow.

RESULTS AND DISCUSSION

Labor requirement and cost of each operation

Table 1 shows the average labor requirement and cost of each operation in the production of cassava. It will be observed that harvesting required the longest time. The man labor was used in cutting and piling of cassava stems, plowing up the roots, and picking and piling the roots. The animal labor was spent in plowing up the roots. The man labor was charged as ₱0.11 an hour and the animal labor was charged at the same rate. The total cost of harvesting was higher than that found by Catambay and Yango in 1935. The variation of the cost of harvesting may be expected because of the difference in yield.

The next labor consuming operation is weeding. The cost of thoroughly weeding one hectare of cassava field is given in table 1.

The preparation of land ranks third in labor requirement. In cassava culture the total cost of land preparation ranks second among the farm operations. The tractor driver who was employed for 7.5 hours during the first plowing received a wage of ₱0.15 an hour. The total cost consisted of labor, depreciation and interest of implements and tractor, and fuel and lubricant for the tractor.

The preparation of cuttings and actual planting of one hectare of land rank third in labor requirement, and cultivation required the least amount of labor. Including charges for the use of the implements, the total cost of cultivation was ₱8.11.

Total cost of production

Table 4 shows the itemized and total cost of production for one hectare of the cassava crop. The total cost of production included labor cost, charges for the use of tractor and implements, cost of fuel and lubricant during the first plowing; cost of planting materials, and land rent. During the first year the total cost of production was higher than that in the second year because 2500 meters of cassava stem to plant one hectare must be purchased at ₱0.05 a meter. During the second year the planting materials can be taken from the first year's crop without cost. The land rent was based on the land rental around the College of Agriculture which is ₱20 per hectare for one year. The average length of time the land was used from its preparation until the crop was harvested was thirteen months.

Yield

The average yield of the six varieties of cassava used in this study was 22,073 kilograms of roots. The age of the plants when harvested ranged from 362 days to 379 days; the average was 371 days.

Cost of producing one kilogram of roots

Table 5 gives the total cost of production of one hectare of cassava. Mendiola (1931) reported that the cost of producing one kilogram of cassava roots in Java is ₱0.009. This figure is slightly lower than that found by the writer during the first season but higher than that in the second season.

Rate of profit on cost of production

The costs of production mentioned above are figures when the roots are just piled on one side of the field ready for hauling. Considering the selling price of cassava roots in the field as ₱0.02 per kilogram, the income from one hectare of land based on the yield of 22,073 kilograms was ₱441.46. With a cost of production of ₱266.42 during the first season, a profit of ₱175.04 was realized or 65.69 per cent. After the first crop, the cost of production per hectare was ₱141.42. With the same yield per hectare as in the first year and the same selling price of the roots in the field, the profit from one hectare of the crop was ₱300.04. The rate of profit on the cost of production was 212.14 per cent. According to the results of this study a farmer can consider cassava a very profitable crop if the roots can be absorbed by the market such as starch factories, distilleries, and other outlets.

SUMMARY AND CONCLUSIONS

The results of this study may be summarized as follows:

1. Of all field operations in the production of cassava, harvesting required the longest time; weeding, second; land preparation, third; preparation of cuttings and actual planting, fourth; and cultivation, fifth.

2. The most expensive operation in raising cassava is harvesting, and the least expensive is cultivation.

3. The total cost of production per hectare of the crop was ₱266.43. This includes cost of planting materials.

4. The average production from one hectare of the crop was 22,073 kilograms. The cost of producing one kilogram of roots was

₱0.012. During the second season when the planting materials were obtained gratis from the farm, the cost of producing one kilogram of roots was ₱0.006.

5. The rate of profit on the cost of production during the first season was 65.69 per cent and 212.14 per cent on the succeeding crops.

6. Cassava is a profitable crop if the roots can be absorbed by the market at the current prices.

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TABLE 1

Average labor requirement and cost of different operations per hectare

OPERATIONS	KIND OF LABOR	NUMBER OF HOURS	COST [a]
			pesos
First plowing (tractor)	Man	7.5	1.23
Second plowing	Man	60	6.60
	Animal	60	6.60
Harrowing	Man	38	4.18
	Animal	38	4.18
Furrowing	Man	20	2.20
	Animal	20	2.20
Preparation of cuttings	Man	70	7.70
Planting	Man	54	5.94
Cultivation	Man	36	3.96
	Animal	36	3.96
Weeding	Man	246	27.06
Harvesting:			
Cutting and piling of stems	Man	94	10.34
Plowing up roots	Man	64	7.04
Picking and piling of roots	Animal	64	7.04
	Man	101	11.11
Total		1008.5	111.34

[a] The labor cost was based upon the following rate:

Tractor driver	₱0.15	per hour
All other laborers	0.11	" "
Animal labor	0.11	" "

TABLE 2

Depreciation of tractor and implements and interest on investment [b]

MACHINERY AND IMPLEMENTS	OPERATIONS	COST	LENGTH OF LIFE IN YEARS	MAXIMUM NUMBER OF DAYS USED IN ONE YEAR	ANNUAL RATE OF INTEREST	NUMBER OF HOURS USED	DEPRECIATION AND INTEREST
		pesos			*per cent*		*pesos*
Fordson tractor	First plowing ...	1600	8	140	10	7.5	1.56
Disc plow	First plowing ...	347	8	100	10	7.5	0.44
Native plow	Second plowing .	17	4	100	10	60	0.31
Native plow	Furrowing	17	4	100	10	20	0.10
Native plow	Cultivation	17	4	100	10	36	0.19
Calmot	Harrowing	5	3	100	10	38	0.08
J. D. Black Lead plow	Plowing up roots	128	8	100	10	32	0.69
Total							3.37

[b] The formulae by Catambay (1931) were used in the computation of charges:

$$\text{Depreciation in pesos} = \frac{cd}{ym}$$

$$\text{Interest in pesos} = \frac{crd}{365}$$

where c = cost of implement or machinery
d = number of 9-hour days used
m = maximum number of days used in one year
y = life of implement or machinery in years
r = annual rate of interest

TABLE 3

Average cost of fuel and lubricant for tractor in plowing one hectare of land

Gasoline, for starting tractor, one liter	₱0.15
Kerosene, 45 liters	4.50
Oil	0.34
Grease	0.05
Total	₱5.04

TABLE 4

Total average cost of production per hectare of the cassava crop

Labor cost	₱111.34
Charges for use of tractor and implements	3.38
Cost of fuel and lubricant for tractor	5.04
Cost of planting materials	125.00
Land rent	21.67
Total	₱266.43

TABLE 5

Cost of producing one kilogram of roots

Total cost of production, per hectare of the crop, first season	₱266.43
Total cost of production, per hectare of the crop, second season (planting materials, free)	₱141.43
Average production per hectare of crop	22,073 kilograms
Cost of producing one kilogram of roots, first season	₱ 0.012
Cost of producing one kilogram of roots, second season	₱ 0.006

TRANSMISSION OF ABACÁ MOSAIC[1]

G. O. OCFEMIA AND MARTIN S. CELINO
Of the Department of Plant Pathology

WITH TWO TEXT FIGURES

On May 4, 1937, Mr. U. Kojima of the Ohta Development Company, Inc., accompanied the senior author to abacá, or Manila hemp (*Musa textilis* Née) plantations in Davao where bunchy-top and mosaic diseases are prevalent and destructive. An examination of the distribution of mosaic of abacá in the field indicated that, like bunchy-top, the disease spreads rapidly in all directions from centers of infection. It was further noted that diseased abacá exhibited many characteristics of plants infected with a virus disease.

On May 12, 1937, the senior author collected several plants of wild *Canna* (probably *Canna indica*) at Bankas, on the way to the Mindanao Reclamation Company plantation at Tunkalan. On account of the resemblance of the mottling of the leaves of the wild *Canna* to that of abacá, the specimens were brought to Los Baños for study (Ocfemia, 1937).

In order to determine the method of transmission of abacá mosaic and the relation of the disease to wild *Canna*, the senior author, requested Mr. Kojima to supply him with corms of mosaiced abacá. The specimens received from Mr. Kojima on May 12, 1937, were collected from Wangan at an altitude of 300 meters. As the mosaiced wild *Canna* brought to Los Baños died after a few months, a request for rhizomes of healthy and diseased plants was sent to Mr. Kojima. The rhizomes were received on August 30, 1938, and were planted in pots immediately.

ECONOMIC IMPORTANCE

The mosaic of abacá is less destructive than the bunchy-top. However, if nothing is done to check its further spread, the mosaic disease, may become as serious as the bunchy-top. When Mr. Kojima visited the College of Agriculture on August 19, 1937, he informed us that in some places in Davao fully 50 per cent of the abacá plants were infected with the mosaic disease.

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[1] Experiment Station contribution No. 1268.

Although insects are suspected as spreading the mosaic disease of abacá in the field, the only method of dissemination known in Davao at present is by means of suckers from infected stools. Calinisan (1934) believes that the abacá mosaic in the Philippines is similar to, if not identical with, the new virus disease of banana in Australia reported by Magee (1930). As Magee states that the new virus disease of banana in Australia may be transmitted by *Pentalonia nigronervosa* Coquerel, Calinisan used this aphid in transmission experiments. His results, however, were negative.

EXPERIMENTS ON TRANSMISSION

In our study of the method of transmission of the mosaic of abacá, the corms of diseased plants were planted in pots and the succulent shoots that developed from these corms were used as source of the virus. The appearance of the leaves of a mosaiced abacá is shown in figure 1.

In our transmission experiments, abacá plants raised from seeds obtained from Paete, Laguna, were used. The seedlings were raised according to the method described by Ocfemia in 1930. The methods of transferring the insects from the source of inoculum to the experimental seedlings and the treatment of the experimental abacá seedlings while viruliferous aphids were being allowed to feed on them were likewise identical with those described by Ocfemia in 1930.

As *Pentalonia nigronervosa* is the vector of bunchy-top of abacá, it was thought that this aphid possibly transmits the mosaic disease also. For this reason, this aphid was used in most of the transmission experiments conducted at Los Baños from July, 1937, to March, 1938. The results of all trials with *Pentalonia nigronervosa*, however, were negative.

In addition to *Pentalonia nigronervosa*, two other species of aphids which are found on abacá and banana were tried. A successful transmission of abacá mosaic was obtained from all trials with the other two species of aphids.

A few experiments were conducted to see whether or not the virus may be transmitted by pin-pricks and by injection of sap extracted from diseased abacá. The results of these experiments were inconclusive. A successful transmission of abacá mosaic, however, was secured when the wounded surface of the midrib of a diseased abacá was allowed to remain in contact with the wounded surface of the midrib of a healthy plant for twenty-eight days.

On April 1, 1938, a number of cotton aphids (*Aphis gossypii* Glover) were transferred to a young sucker of one of the mosaiced abacá plants from Davao. The plant with the aphids on it was covered with a cheesecloth bag. After allowing the aphids to feed on the diseased abacá for two weeks, 30 to 40 individuals were picked out with the narrowed point of a moist camel's hair brush and transferred to a healthy abacá seedling. The abacá seedling used in the

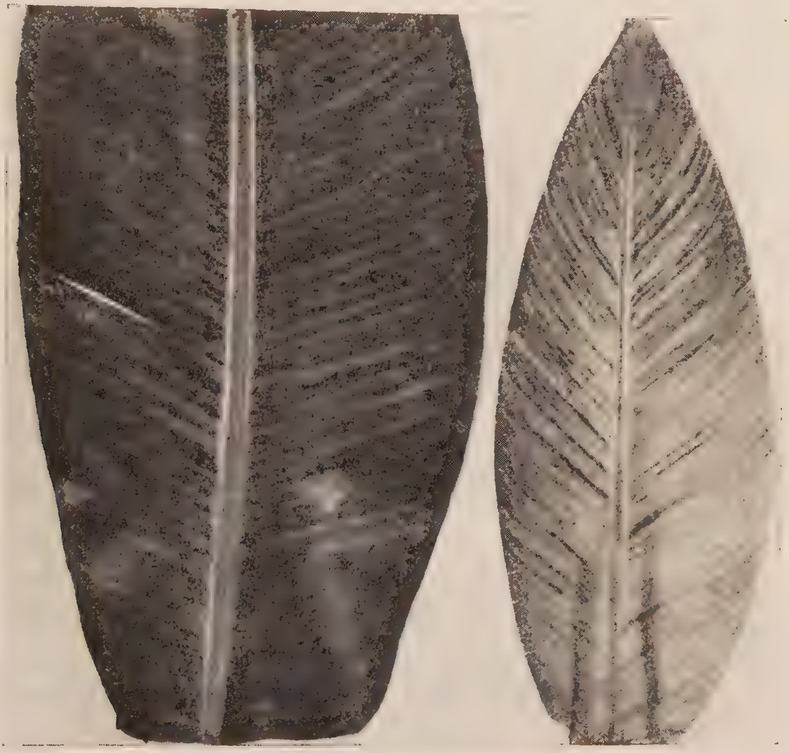

Fig. 1.—Two leaves of abacá produced by suckers that grew from the corms supplied by Mr. U. Kojima, of the Ohta Development Company, Inc., Davao. The larger leaf to the left shows dot-like discoloration, or the site of these dot-like yellow areas as well as the narrow and broken streaks producing a more or less mottled effect. The smaller leaf to the right shows a more advanced stage of infection with many of the streaks merged together longitudinally and laterally producing continuous bands. Only very narrow streaks with green color may be seen on the photograph. Photographed by the Photographic Division, Department of Soils, July 14, 1937.

experiment had four leaves on it and it was growing vigorously. The inoculated plant was bagged with cheesecloth to protect the aphids from predators and to prevent other insect from interfering with the experiment.

On May 3, 1938, or after an incubation period of 18 days, the abacá seedlings on which *Aphis gossypii* from mosaiced abacá were allowed to feed showed symptoms of the mosaic disease.

Three other healthy abacá seedlings of the same age were selected and used in transmission experiment. The same number of *Aphis gossypii* from mosaiced abacá were transferred to each of the three seedlings. When the required number of aphids had been transferred, the seedlings were covered with cheesecloth bags. In the three seedlings used, symptoms of mosaic infection began to appear after an incubation period ranging from 15 to 22 days.

In order to confirm the results of the two experiments, on July 30, 1938, and again on August 10, 1938, large numbers of winged and wingless adult *Aphis gossypii* collected from cotton from the cultures of the Department of Agronomy were transferred to a young mosaiced abacá seedling. The mosaiced abacá seedling with the cotton aphids on it was covered with a cheesecloth bag to allow the insects to feed undisturbed.

On August 27, 1938, twenty-five young *Aphis gossypii* from the mosaiced abacá were transferred to young and healthy abacá seedlings and these with the insects on them were covered with cheesecloth bags.

On September 5, 1938, twenty-five young *Aphis gossypii* from the mosaiced abacá were transferred to young and healthy wild *Canna* from Davao. The *Canna* plants with the cotton aphids on them were likewise covered with cheesecloth bags.

On September 23, 1938, the abacá plants on which the viruliferous *Aphis gossypii* were allowed to feed had definite symptoms of mosaic, after an incubation period of 28 days. The wild *Canna* also had unmistakable symptoms of mosaic after an incubation period of 18 days. The appearance of the leaf of the wild *Canna* with mosaic disease is shown in figure 2. It is thus concluded that *Aphis gossypii* Glover is a vector of abacá mosaic and the disease may be transmitted to wild *Canna* by the same insect. Besides *Aphis gossypii*, two other species of aphids transmit the mosaic not only to abacá but also to wild *Canna*.

SYMPTOMS IN EARLY STAGES OF INFECTION

In aphid-transmission experiments of abacá mosaic, the first symptom of infection may be noted on the first leaf that unfurls after viruliferous aphids have been allowed to feed on abacá. A number of dot-like light colored areas ranging in size from one half to one millimeter in diameter may be noted. These dot-like areas seem to indicate the places where the aphids had fed. As the veins of the leaves limit the progress of the spots, the yellowed areas grow very fast in the direction of the veins. The oblong discolored areas may vary in size from one or one and one-half millimeters to two and

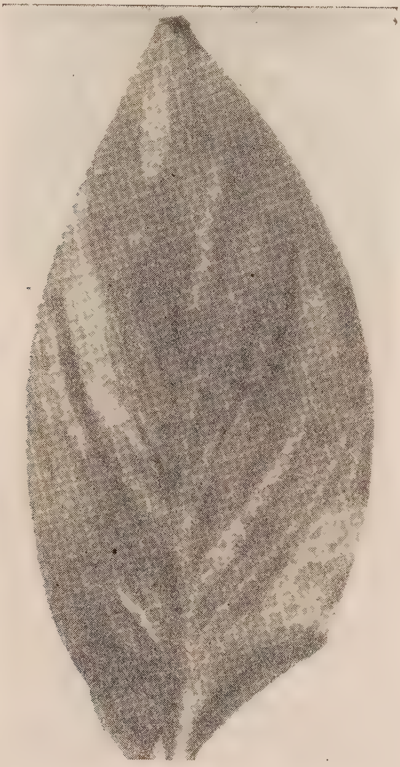

Fig. 2.—A leaf of wild *Canna* from a mosaiced plant collected by the senior author from Bankas, Davao, on May 12, 1937, and grown in pot in the College of Agriculture at Los Baños. Photographed by the Photographic Division, Department of Soils, June 21, 1937.

one-half by three to fifteen or more millimeters. Some of the elongate discoloration may extend from the midrib to the margin of the leaves. Even after the yellowish white areas have attained a length of ten to fifteen or more millimeters, the site of the original more or less circular discoloration is still very distinct.

As soon as the elongate spots appear on the leaves the same shape and size of light colored areas may be seen on the nether surface of the midribs and on the petioles.

On the succeeding leaves the symptoms gradually become more conspicuous until the entire foliage may assume a greenish yellow hue owing to the coalescence of neighboring lesions.

On wild *Canna* the symptoms develop in practically the same manner. The formation of elongated yellowish green streaks, however, may be seen about twenty days after the appearance of the first symptoms.

SUMMARY

1. The mosaic of abacá in Davao is less destructive than bunchy-top but the disease is spreading rapidly.
2. The abacá mosaic virus may be transmitted when the wounded surface of the midrib of a diseased abacá is allowed to remain in contact with the wounded surface of the midrib of a healthy plant.
3. Abacá mosaic may be transmitted by the cotton aphid (*Aphis gossypii* Glover) and two other species of aphids to abacá and wild *Canna*.
4. In aphid-transmission experiments the first symptom of infection is the presence of circular yellowish green spots about one millimeter in diameter. Owing to the veins of the leaves, the growth of the spots follows the direction of the veins forming streaks or bands. The site of the original-dot-like spots remains distinct even after the bands are ten to fifteen millimeters long. The yellowish bands may be seen on the nether surface of the midribs and petioles.

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OCFEMIA, G. O. 1937. The abacá-disease situation in Davao. The Philippine Agriculturist **26**: 229–236. *Fig. 1–2.*

IN MEMORIAM: JAMES EDGAR HIGGINS[1]

With profound sorrow, we announce to the many friends of James Edgar Higgins, former Professor and Head of the Department of Agronomy of the College of Agriculture, University of the Philippines, his untimely death in Pasadena, California, on July 22, 1938. Interment took place in Redlands, where his wife was buried several years ago.

In the death of Professor Higgins, the world, especially the tropics, has lost a very able horticulturist, whose many valuable attributes—practicality, scientific training, special aptitude, and love for work are well known.

Professor Higgins was born on June 14, 1873, in Wolfville, Nova Scotia, Canada. He received his bachelor of arts degree from Acadia University in 1895, and the following year, a diploma from Nova Scotia School of Horticulture. He took post graduate work in Cornell University, where he obtained the degree of Master of Science in Agriculture in 1898.

In his earlier days, Professor Higgins held various educational positions: he was a teacher in Horton College Academy in 1896; teacher of agriculture in Honolulu Normal School from 1898 to 1900, and supervisor of agriculture in Honolulu Schools from 1900 to 1903.

His special preparation in horticulture merited his appointment as a horticulturist of the Hawaii Agricultural Experiment Station under the United States Department of Agriculture. He liked his work in Hawaii so much that except for a year in Porto Rico (1913-1914) as a Professor of horticulture at the State University he remained in the Hawaii Station from 1903 to 1920. During his stay in Hawaii, he began to attract attention as a tropical pomologist and long before he left there, he had already earned an enviable position among world renowned agricultural scientists, plant explorers, and educators. His many publications, including some on the most important fruit plants and other horticultural crops, still remain models for similar treatises.

He came to the Philippines on January 28, 1920, in response to a special appeal by our late Dean Baker for assistance in horticultural work in this College and stayed at Los Baños as Professor and Head of the Department of Agronomy from 1920 to 1925.

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[1] General contribution No. 621.

During his stay at this College, he helped promote advancement not only of horticulture but also of various other branches of agronomy. Besides attending to his duties as a professor, he spent his private time training assistants and promising students, initiating them into the many intricacies of the horticultural vocation, full mastery of which Professor Higgins never boasted but unquestionably possessed.

While in the Philippines, he travelled much through the country, mostly at his own expense. Some of his specific recommendations are extensive planting of important kinds of citrus in some parts of Bukidnon, wider dissemination of choice varieties of avocados, and the search for and rapid multiplication of desirable strains of agronomic and horticultural crops for the Philippines.

Other branches of our government also profited by the counsel of Professor Higgins, who served in various capacities. One was his appointment in 1925 as a consulting horticulturist of the Bureau of Agriculture, now Bureau of Plant Industry.

Towards the middle of 1925, the ill health of his wife, a very sympathetic, lovable character, necessitated their early return to America so that he was forced to sever his connections with the University even before the end of the school year, in December, 1925.

That he never forgot the Philippines could be partly gauged from his regular shipment of new and noteworthy plants from the Panama Canal Zone Experimental Gardens, of which he was Director from 1927 to about a year ago, when he had to retire from active duty on account of his failing health. He often remarked that he felt greatly at home in Hawaii and the Philippines, and that if he had his own way, he would spend the rest of his days in either of the two countries.

He went to Pasadena about a year ago, presumably to recuperate from the heart affection that had been bothering him. But even when he was in search of peace and quietness, he had an assistant under training, for he could not help but disseminate the wisdom that had taken him a lifetime to gather, and which made him a world figure in horticulture.

Professor Higgins was a member of many distinguished societies, including the American Association for the Advancement of Science, American Society for Horticultural Science, American Pomological Society, and American Genetic Association.

He died at the age of sixty-four, leaving an only son, two grand children, and a sister.

In the death of Professor Higgins, the Philippines has lost a very able friend and admirer, and the world, a leading tropical horticulturist.

L. G. GONZALEZ
Of the Department of Agronomy

A REVIEW: "THE COCONUT, A MONOGRAPH [1, 2]

The general interest on various phases of the coconut industry finds a striking expression in the publication, in 1938, of a monograph on the coconut. This book is the result of the efforts of the author to bring together all of the important publications on coconut from 1885 to 1934, in different institutions, including the College of Agriculture, University of the Philippines. In addition to published works the book includes unpublished results of experiments on coconuts carried on by the Department of Agriculture in Madras, India. Many of the branches of the coconut industry are well treated and these furnish information not hitherto recorded in any of the books on coconut.

The most notable feature of the book is the wealth of experimental data and their interpretation. These data are of great practical value to coconut planters because they point out the best practices that should be followed in coconut production.

The book deals at some length with the botany and other fundamental and scientific aspects of the coconut palm. The treatment of the cultural phase of the coconut is well arranged but one could wish it were more complete. The explanation and discussion of pertinent and valuable publications are given in a manner that is easily understood supported with tabulated data and graphs.

The author discusses concisely and clearly the history, culture, botany, manuring, cultivation, yield, germination and selection, the nuts—copra and oil, coconut products, tapping for toddy production, diseases and pests, and abnormalities in the palm.

In connection with the bibliography, a few errors have crept in. Given names of some of the authors are separated by comma and are used as surnames. In some cases it seems that the author probably did not have access to the original articles cited. This criticism, however, is a very minor one and does not in any measure affect the value of the mass of information contained in the book.

PEDRO A. DAVID
Of the Department of Agronomy

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[1] PATEL, J. S. 1938. The coconut, a monograph. vii + 313 p., 29 fig. Madras: Government Press.

[2] General contribution No. 622.

COLLEGE AND ALUMNI NOTES

The following alumni of the College of Agriculture have been appointed members of various committees of technical consultants to the National Economic Council of which the Dean of the College is an ex-officio member of the board of directors:

1. Dr. Manuel L. Roxas
2. Dr. Francisco O. Santos
3. Dr. Nemesio B. Mendiola
4. Dr. Vicente C. Aldaba
5. Dr. Eulalio P. Baltazar
6. Dr. José J. Mirasol
7. Dr. Valeriano C. Calma
8. Mr. Antonio Lejano
9. Mr. Domingo B. Paguirigan
10. Mr. Francisco D. Marquez
11. Prof. Vicente B. Aragon
12. Dr. Anastacio L. Teodoro
13. Dr. Francisco M. Fronda
14. Dr. Valente Villegas
15. Director Hilario S. Silayan
16. Dr. Francisco M. Sacay
17. Dr. Pedro A. David
18. Dr. Deogracias Villadolid
19. Dr. Silverio M. Cendaña
20. Dr. Getulio A. Guanzon
21. Dr. Leopoldo B. Uichanco
22. Mr. Faustino Q. Otanes
23. Dr. Eduardo Quisumbing
24. Dr. G. O. Ocfemia
25. Dr. Dionisio I. Aquino
26. Dr. Pablo N. Mabbun
27. Prof. Alejandro B. Catambay
28. Dr. José B. Juliano
29. Dr. Rafael B. Espino
30. Dr. Leon G. Gonzalez

Of these alumni the following are on the faculty of the College of Agriculture at present:

1. Dr. Francisco O. Santos
2. Dr. Nemesio B. Mendiola
3. Dr. Eulalio P. Baltazar
4. Dr. Valeriano C. Calma
5. Prof. Vicente B. Aragon
6. Dr. Anastacio L. Teodoro
7. Dr. Francisco M. Fronda
8. Dr. Valente Villegas
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15. Dr. Dionisio I. Aquino
16. Dr. Pablo N. Mabbun
17. Dr. José B. Juliano
18. Dr. Rafael B. Espino
19. Prof. Alejandro B. Catambay
20. Dr. Leon G. Gonzalez

The following technical consultants are not alumni of the College of Agriculture but are on its faculty:

1. Professor José E. Velmonte
2. Dr. Antonio I. de Leon
3. Dr. Nicolas Galvez
4. Dr. Miguel Manresa

The 1938 Loyalty Day celebration was held on the Campus on October 10 with Honorable Manuel A. Roxas as guest of honor.

The following sections in the 1938 Loyalty Day Parade on October 10 took prizes:

Department of Agronomy: first prize
Department of Animal Husbandry: second prize
Los Baños Economic Garden and Department of Agricultural Chemistry: honorable mention

The committee which selected the prize winners was composed of Mesdames Jorge Bocobo, B. M. Gonzalez, H. L. Richards, and H. M. Curran.

On October 24, Dean and Mrs. B. M. Gonzalez were at home to friends, and the faculty, employees, and students of the College of Agriculture at the Seniors' Social Garden from four-thirty in the afternoon to eight o'clock in the evening. About one thousand people, including the faculty of the School of Forestry and the Maquiling School, came to congratulate the Dean on the occasion of the tenth anniversary of his appointment to the deanship of the College, for the outstanding accomplishments of the Institution under his leadership. As a symbol of their appreciation for the distinguished service of the Dean, and as an expression of their assurance of continued loyalty and cooperation, the faculty and employees of the College of Agriculture, the senior and junior organizations, and the returned fellows and pensionados from the United States and from Europe, each presented appropriate gifts.

HOW TO SLAUGHTER AND DRESS FARM ANIMALS [1]

VALENTE VILLEGAS AND M. MONDOÑEDO
Of the Department of Animal Husbandry

WITH TEN TEXT FIGURES

The purpose of this circular is to disseminate information on the proper slaughtering and dressing of farm animals as an incentive to greater consumption of meat.

SELECTION OF ANIMALS [2]

To obtain good results, the following points should be considered in the selection of animals:

Type. A short, closely-coupled, broad and stocky type of animal is desirable. The muscles should be short and plump. The Batangas strain of Philippine cattle approaches this type (fig. 1). The Philippine-Nellore crossbreed ox also possesses the conformation satisfactory to the butcher (fig. 2). A greater proportion of the Nellore blood tends to produce an animal that is leggy, upstanding, and bony. In swine, a good type of butcher stock is represented by the Berkjala breed (fig. 4) as well as by grade (mestizo) pigs as those raised in the province of Batangas. Indian sheep possess a bigger and a more meaty leg of mutton than the Philippine animal (fig. 5). Among goats, the native animal, although smaller, shows a more desirable conformation for meat purposes than the milch type.

Temperament and disposition. The ideal meat animal is passive and slow-moving. It fattens readily. It is also docile and safe to handle.

Quality. The better the quality of the animal the greater is its dressing percentage and the more wholesome is its meat. Quality in a living animal is shown by the fineness of bone, skin, and hair. The meat from such animals contains fat which is uniformly interspersed between the muscle fibers throughout the whole carcass.

Health. In no case should an animal suspected of harboring disease organisms be slaughtered for food. A few days of observation before butchering will enable one to determine the behavior of

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[1] Experiment Station contribution No. 1279. Circular 31.

[2] HELSER, M. D. 1923. Farm meats. xv + 274 p., 125 fig. New York: The Macmillan Company.

THE PHILIPPINE AGRICULTURIST, VOL. XXVII, No. 8, JANUARY, 1939.

the animal. A lustrous coat, bright eyes, and an alert appearance are signs of good health, whether the animal is fat or thin. General emaciation and paleness of the mucous membrane indicates an anemic condition, which may be the result of parasitism, tuberculosis or other causes. In a dressed carcass, generalized tuberculosis is manifested by the presence of pus pockets inside the body.

Condition. The degree of fatness of a meat animal is referred to as its condition. Ordinarily, the fatter the animal the more valuable is its meat. Besides being juicy, the flavor imparted after cooking is appetizing. Too much fat, however, is not often desired. This may be noted in the appearance of rolls of fat on the back of a steer, or by the excessive development of a flabby jowl and ham in the pig. When boiled, the broth from the meat of an over-fattened animal becomes oily and unappetizing.

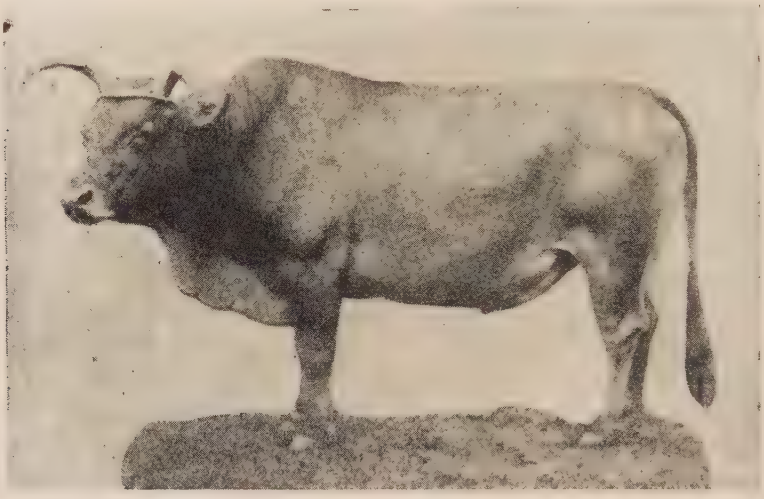

Fig. 1.—A Batangas steer exhibiting the desirable features of a beef ox viz., blockiness and muscularity. Weight, 451 kgm.

Unsexed animals, either male or female, fatten readily and become heavy and plump when in their best condition. Figure 3 shows three spayed cows which gave an average dressed weight of 186.3 kgm. each and an average dressing percentage of 51.9.

Age. No animal should be killed for food below three or four weeks of age. Over this age, the animal is considered young for slaughter until it is one year old, and mature when older. The meat of a calf which is one year of age or below is called *veal;* that of a mature ox is known as *beef*. Swine meat is designated as *pork*.

With sheep, the meat of the lamb is referred to as *lamb meat*, and that of the mature individual, as *mutton*. Goat meat is called *chevron*.

Size. It is evident that the heavier the animal for its age the more profitable it will be. It takes only a little more effort to dress a bigger animal than a small one. For the block, the height of an animal is inconsequential, its weight being more important.

SITE

It would be ideal to have a sanitary and well-equipped permanent butcher shed in which the slaughtering of animals may be done at any time. However, the cost and maintenance of such structure by a farmer who slaughters animals only occasionally may prove too expensive. In its place, a vacant space in a building with concrete flooring may be used. Under favorable weather conditions, a clean paddock with a thick growth of grass affords a good site for slaughtering an animal. A tree with low, stout branches on the paddock is an advantage. It furnishes shade. The branches serve as beams to which the pulley for hoisting the animal may be attached. All shrubbery nearby should be cut down. Any manure or rotting material should be removed.

Fig. 2.—A Nellore-Philippine ox. Age, 2 years, 3 months; weight, 375 kgm.

MANAGEMENT OF ANIMAL BEFORE SLAUGHTER

An animal coming from a nearby district should be shipped shortly before it is slaughtered to prevent great loss of weight through shrinkage. From distant ports, however, it is advisable that the animal arrives sometime before it is disposed of to enable it to recover lost flesh by intensive feeding. On the boat or train the animal should be treated well, avoiding slipping and bumps. Bruises on the body show badly after dressing and cause the meat to deteriorate readily. With pigs a thick bedding of rice straw is very helpful, whereas with large animals, sand spread on the floor will keep them from falling. During the voyage, pigs should be cooled by having water poured over them at frequent intervals, particularly at midday, to reduce to the minimum losses from heatstroke. In all cases, the animals should not be exposed to direct sunlight or heavy rains for any protracted period of time. Sudden changes in temperature and other environmental conditions are also detrimental and may lead to fatal pneumonia. Frequent watering while in transit is beneficial. On the other hand, full grain feeding is bad. The feeding of slop to pigs seems satisfactory.

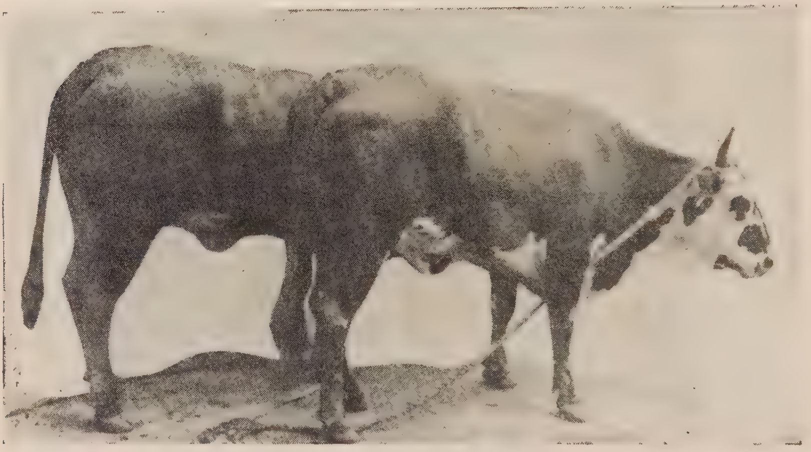

Fig. 3.—Well-fattened spayed cows which were rated *primera extra* at the Manila slaughterhouse.

Upon arrival of the animals it is best to place them in a comfortable barn provided with a sanitary floor and plenty of ventilation. They should be given fresh water as soon as they have rested. If dirty they should be thoroughly cleaned. Pugnacious individuals as well as those that are excitable and restless should be separated from the main herd.

Before slaughter all animals should be deprived of feed for about twenty-four hours. Water should, however, be given to them.

TOOLS

The butcher's kit should be provided with the following tools (fig. 6):

Matador. This is a heart-shaped tool with a strong, sharp, and pointed blade by which the carabao or ox is stunned. The word matador, literally, means killer.

Skinning knife. For skinning, the knife should be stout and gracefully curved. The blade should be kept only fairly sharp. If whetted too much the skin is likely to be cut through and spoiled. There should be two or three of this kind of knives in the kit.

Cutting knife. A longer and wider knife than for skinning is desired for cutting the meat. The body is relatively straight and the handle should be strong. If should be kept very sharp while in use. Four knives of this kind would be a good set to have. Whenever possible, the cut should be made across the muscle fibers.

Fig. 4.—A yearling Berkjala barrow of desirable age and size for slaughter. Weight, 84 kgm.

Cleaver. This is used in cutting the bony portions of the carcass. Consequently, it should be made of the highest grade of steel. If of low quality the blade easily becomes dull and gets nicked upon striking hard bones. The body and handle should be thick and strong. It should be made fairly sharp before it is used.

Saw. The butcher's saw is provided with the best quality of blade to be able to cut through the bones effectively. There should be handy an additional one or two blades to replace the one in use when the teeth become dull.

Axe. With big bones, the axe may be used more conveniently than the cleaver for cutting. The blade should also be of the best quality. It should be moderately sharp like the cleaver.

Scraper. The steel scraper is a convenient and efficient tool for removing the hairs and scurf of the pig after scalding. In lieu of this, however, a dull knife may be used.

Meat grinder. A machine for grinding meat is a useful equipment to have to convert the trimmings and tough meat cuts like the flank and diaphragm into a wholesome food material called *hamburg.* The hamburg is prepared by mixing about 100 grams of common table salt and about 20 grams of pepper with 5 kgm. of ground beef. Meat of other classes of animals may also be turned into the same product. The taste and texture of beef, carabao meat, mutton, or chevron may be improved by mixing with about one-fourth or one-third of ground pork.

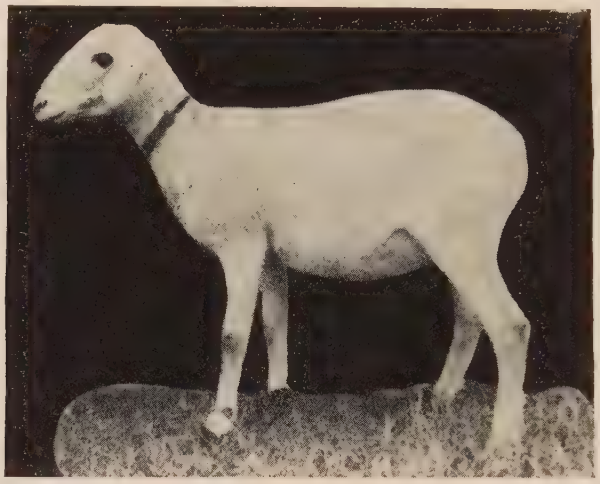

Fig. 5.—A grade Indian wether of the right age and size for slaughter. Age, 18 months; liveweight, 36.0 kgm.; dressed weight, 18.0 kgm.

Gambrel or spreader. Various lengths and sizes of gambrels or spreaders according to the classes of animals for which they may be used should be provided. The gambrel for a goat is, of course, much smaller than that for the ox. For a small animal, the texture and strength of the wood of which the gambrel is made does not matter much, whereas for heavy and big individuals it should be strong. Guijo, yakal, or molave will make strong gambrels. The length should be sufficient to spread the hind legs far apart. For goats and sheep, the gambrel is about 50 cm. long, for swine 55 cm., and for cattle and carabaos 85 cm.

Cans and barrels. Empty kerosene cans are necessary for boiling water for scalding purposes. A large empty barrel is a convenient receptacle for hot water into which the pig is dipped and scalded before the hair is removed.

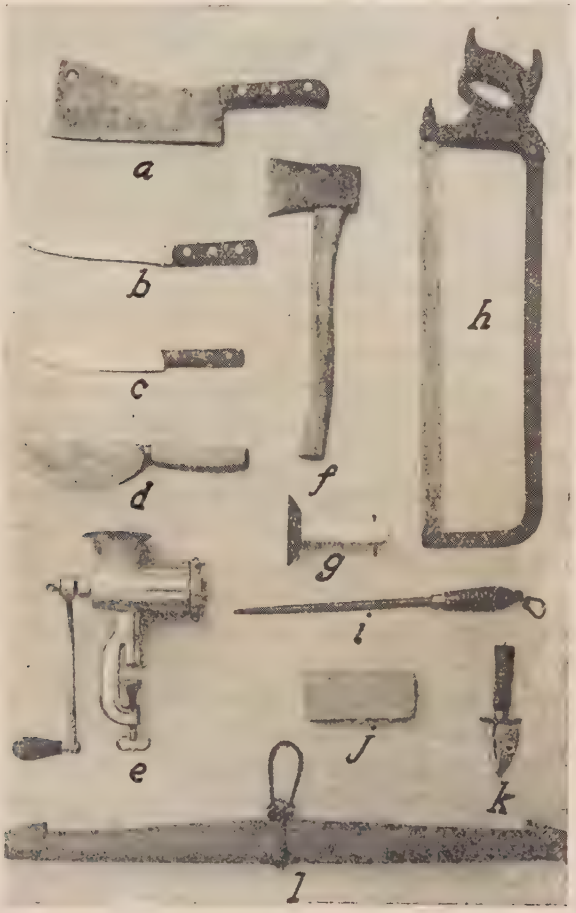

Fig. 6.—Set of tools necessary for butchering farm animals: *a*, cleaver; *b*, sticking knife; *c*, cutting knife; *d*, skinning knife; *e*, meat grinder; *f*, axe; *g*, scraper; *h*, saw; *i*, steel; *j*, whetstone; *k*, matador; *l*, gambrel or spreader.

Pulleys and ropes. Strong pulleys and ropes for raising the carcass are necessary.

Whetstone and steel. These are important accessory tools of the butcher to keep the knives, cleaver, and axe sharp.

A small supply of rendered lard or tallow is useful in treating iron tools to prevent them from becoming rustry during storage.

CATTLE AND CARABAOS

The method of slaughtering cattle and carabaos is similar. Both are stunned before they are bled. In general, the carabao needs stronger ropes, pulleys, and beam on which it is raised owing to its heavy weight.

Stunning. The animal may be stunned in two ways: by shooting or by striking the animal with a sledge hammer at the intersection of the diagonal lines connecting the eyes with the bases of the horns, or by hitting with the point of the matador at the spinal cord at the top of the neck close to the head. The use of the matador is humane and in the hands of an experienced butcher it is very effective in stunning the animal. The animal is tied close to a tree or post with its head pulled slightly down by a strong rope. With the butcher standing on the right side of the animal, the matador is thrust perpendicularly downward to the top of the neck causing the animal to go down immediately on its legs.

Bleeding. The next step is to lay it on the floor on the right side. The skin over the windpipe is cut starting from the brisket to about 35 cm. towards the head. A pocket is made beneath the skin by separating a portion of it from the carcass. The knife is stuck about five centimeters towards the chest with its back against the brisket. The carotid arteries and jugular vein are cut by raising the knife slightly towards the back of the animal. Care should be taken that the knife is not pushed further towards the lungs lest much blood would accumulate in the chest cavity. As the blood accumulates in the hollow of the skin it should be scooped out and placed in a clean receptacle. A handful of salt stirred in the blood will prevent it from coagulating and spoiling. The body of the animal may be pressed to cause the blood to drain out as completely as possible.

Skinning. The animal is now placed on its back. This is best done by putting clean blocks of wood or stones on each side of the animal. The skin is first cut at the head on one side of the face. The cut is connected with the opening previously made in front of the brisket. It is continued towards the abdomen and on to the rectum. Skinning is made on each side of this cut beginning with the head. The skin around the lower joints of the knees and hocks and the base of the tail is also cut and from here it is opened on the inside of each leg straight up to the midline. In separating the skin from the flesh the blade of the knife should be directed away from the skin to prevent cutting the latter. Towards the side and back of the animal, much difficulty will be encountered in separating the lean tissues lying next to the skin. Hence, during skinning it may be allowed to go with the skin to be removed later before the hide is salted or sold. By the time skinning is over, the four shanks and tail are removed with the skin on. These are sold as such after the hair has been removed by scalding and scraping. The shanks are disconnected at the smooth or lower joints. If not separated at these joints the carcass will drop when hoisted.

Disemboweling. Preparatory to disemboweling, the head is disconnected from the neck at the juncture of the atlas and the axis just back of the head. The brisket is next cut open at the middle with the axe or saw. From here the opening is extended to the neck over the wind pipe and in the other direction the cut is made towards the rectum with the handle of the knife held towards the viscera. The heart and lungs are detached from their connection with the chest and the diaphragm is removed. The carcass is now ready for hoisting. The spreader is placed by inserting the hooks at the openings made at the hollow between the back tendon and lower thigh of the hind legs. Slowly, the carcass is raised up by means of the rope tied at the middle of the spreader, the rope passing through the pulley attached above. As the carcass is hoisted, the abdominal contents are allowed to drop down gradually to the floor. By this time, an opening should have already been made around the rectum and the latter tied securely with a stout string to prevent the feces from dropping out. The bladder with its content should have also been carefully removed and discarded (fig. 7).

Sawing the carcass into two. At first the pelvic bone or aitchbone is cut across. Then, from where the tail was cut off, the carcass is sawed downward through the middle of the spinal column. The gambrel should be long to spread the hind legs sufficiently and facilitate sawing. Care should be taken that the blade does not switch to one side making it hard to return and follow the middle line again. The beginner would do better by getting the aid of a helper, the two pulling at each end of the saw during the operation. In the absence of a saw, the axe may be used although the cut does not look as smooth as with the saw. About 10 cm. of the carcass should be left uncut until after it has been quartered.

Quartering. With the carcass hung up on the hook, the ribs are counted from the front rib to the twelfth rib. Between this and the thirteenth rib, at 7 in fig. 8, an opening is made. Then from where the backbone starts to rise at 6 towards the tail, the vertebrae are counted to the seventh and a half number at 4. The knife is now inserted at the opening previously made between the twelfth and thirteenth ribs and carried to the seventh and a half vertebra at 9 thus dividing the carcass into the fore and hind quarters. The saw is used in cutting across the vertebrae.

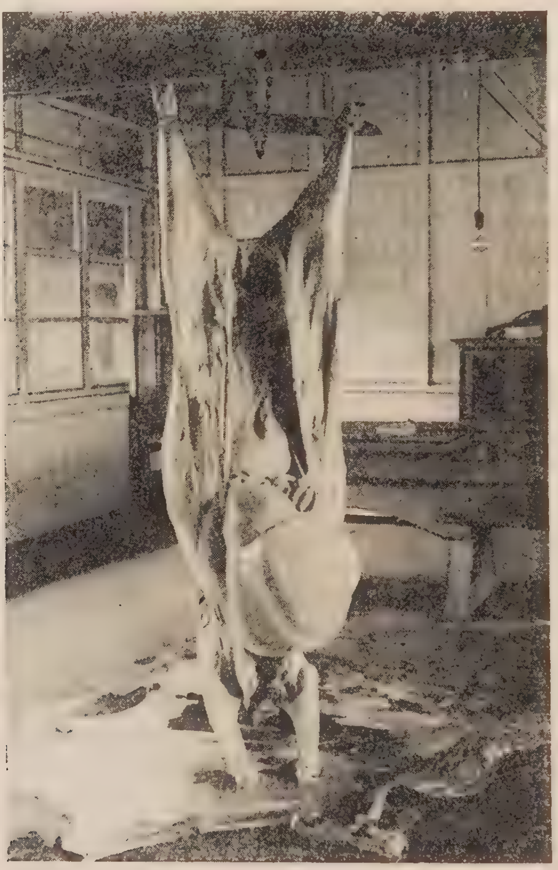

Fig. 7.—Removing the viscera from a beef carcass.

Choice cuts. The hind quarter contains the best cuts of the whole carcass such as the loin and the round. With the hind quarter lying on its flesh side, the kidneys are first removed, care being taken that some fat is left to cover the tenderloin or "filet" of beef located beneath the vertebrae. The flank is next separated by drawing the knife from 3 to 7. Now, a cut is made downward from where the vertebrae starts to rise as from 6 to 5. From 6, four bones are counted to 4, and from this point the meat is cut about three or four centimeters in front of the aitchbone down to 3. Lastly, another cut is made below and parallel to the pelvic arch as from 1 to 2. The different cuts of the hind quarter are the round, rump, loin end, short loin, and flank. The loin end and short loin together make

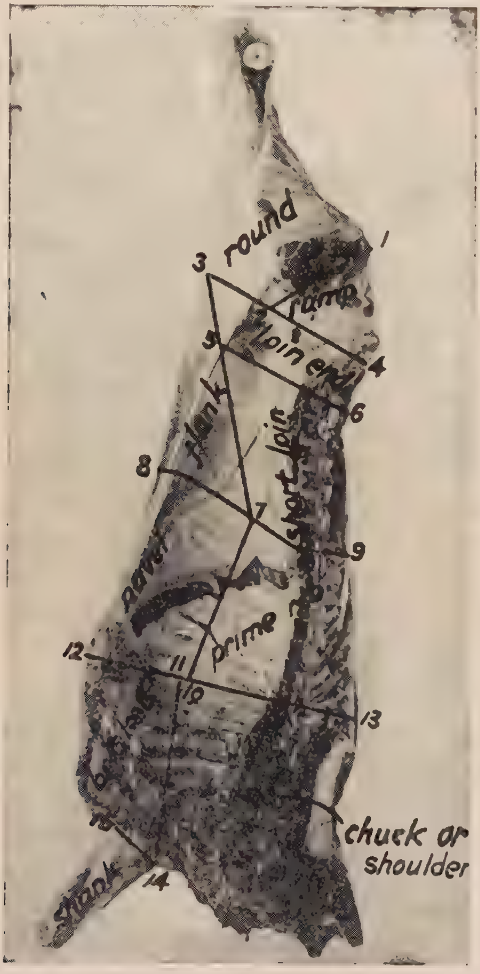
3
round
1
rump
5
loin end
4
6
flank
short loin
8
7
9
navel
prime
12
11
10
13
15
14
shank
chuck or
shoulder

Fig. 8.—One-half of a beef carcass showing principal cuts.

up the loin. Club steaks come from the rib end of the short loin and porterhouse steaks from the other end. Both the club and porterhouse steaks may correctly be named T-bone steaks owing to the presence of the T-shaped bone in each. The tenderloin present in this cut may be pulled off and prepared as steak. From the loin end, the cuts are called sirloin steaks. The rump may be used for roast or stew. A good portion of the round at the top gives steaks and roasts, while the remainder may be boiled for soup. The flank contains a plump muscle known as flank steak. The rest of the flank may be ground to make hamburg.

A prime rib roast consisting of seven ribs may be prepared from the fore quarter between 7-9 and 10-13. Two additional ribs in front of 10-13 in the region of the chuck or shoulder also make a good roast although not as tender as the portion towards the loin. The shoulder may also be used for roasts of various sizes.

Another method of cutting may be followed whereby the lean from the round and shoulder is separated from the bone and considered as steak material. The thick muscle on the back in the regions of the prime rib, loin, and rump make excellent steaks.

Ordinary cuts. The ribs, neck, and brisket may be classed as ordinary cuts. They are a mixture of lean and bone and are suitable for stews or for boiling purposes. The brisket is particularly valuable for the purpose owing to the good flavor imparted by the fat it contains and the short fibers of its lean tissues.

Soup stock. In cuts from which the lean has been separated from the bones, such as in the round, rump, loin, on the back of the prime rib and in the shoulder, the bones are classified as soup stock. The lower portion of the round and the shank, being mainly bone, falls into this category. The bones of the shoulder, shank, round and rump, being richly laden with bone marrow, are much more valued than the rest.

Tongue and brain. From the head, the tongue with its attachments are disconnected at the base. The brain is obtained by chopping the skull on each side above the eyes with the axe. The muscles of the lower jaw are also cut and mixed with other trimmings for hamburg.

Legs and tail. These are scalded and the hair is scraped off. The hoofs and dew claws of the legs are knocked off. As such they are used for the preparation of a local dish known as *kare*.

Entrails. The most valuable portion of the entrails is the liver. Its price is on a par with that of the choice cuts. In separating it, care is taken that the gall bladder is not destroyed lest the bile may spread and render its taste bitter. The bile duct is carefully detached from the liver and slowly pulled up together with the gall bladder. Next, the heart, spleen, and lungs are also put aside from the rest. The kidneys, which have been removed from the loin, are included in the entrails. They are opened and the middle portion is pared off. After the contents of the alimentary tract have been removed, the different regions are thoroughly washed. Only the windpipe is eliminated as waste.

Storing the hide. If the hide is to be treated for tanning immediately after slaughtering the animal, all that is necessary is to remove the muscle fibers that may still be present and to wash it. If it is to be stored for some time, about three centimeters of salt are applied on the flesh side. The edges are folded to meet at the middle, forming a small square; then it is rolled up and tied with a stout twine.

Dressing percentage. The dressing percentage of an animal is represented by the dressed weight divided by the fasted live weight times one hundred. The dressed weight of an ox is obtained after the head, legs, hide, tail, and entrails, including the kidneys, have been removed from the carcass. Records of the College of Agriculture show that Batangas cattle dress from 41.6 to 52.9 per cent, the average being 46.8 per cent. The average dressing percentage of Philamin cattle is 50.6. One Nellore-Philippine crossbreed cow dressed 51.4 per cent and two fat Nellore cows gave an average dressing percentage of 59.9 per cent.

SWINE

Pork being a popular meat in the Philippines, many persons are adept in the slaughtering of swine and the preparation of its carcass for the market. The relative ease with which hogs may be dressed compared with the ox or carabao also accounts for the greater number of persons that are skilled in dressing them.

Sticking. Provide a box or table on which the pig is laid on the right side with the head and neck projecting at one end of the platform. The pig should be hog-tied. The butcher with his left hand holding the head down sticks the point of the knife about six centimeters deep in front of the breast bone, the blade of the knife being held towards the right. Next, the knife, with the blade turned towards the head of the animal and the end pointing to the neck bone away from the heart is thrust until the point touches the bone thus cutting the carotid arteries where they branch. Following this the blood flows copiously and is collected below in a receptacle.

Scalding, scraping, and cleaning. Before the pig is killed, hot water for scalding should be prepared. The correct temperature for this purpose is about 65°C. which in practice is determined by dipping the index finger such that on the fourth dipping the finger can no longer stand the heat. The pig is immersed in hot water first by the fore quarter, which is immediately scraped after removing it from the water. Then, the same operation is repeated with the hind quarter. A scraper or dull knife may be used for the purpose. Hair located in sunken parts which can not easily be scraped is shaved off with a sharp knife. Following this the dirt on the skin is removed by brushing and washing with soap, or by scraping it with papaya or isis (*Ficus ulmifolia*) leaves. Lastly the skin is scraped dry by passing the back of the knife over it.

Removing the entrails. With the pig hanging by its hind legs, the skin is cut at the middle of the belly from the rectum down to the neck. Next, the breast bone and the aithchbone are split open with the cleaver. The rectum, which is now exposed, is loosened by cutting the skin and tissues around it and then tied. The head is cut off at the atlas joint about five centimeters behind the ears. The viscera are then severed from their attachments, starting from the top down, and removed. Any blood stains on the carcass are washed. Among the important parts of the entrails are the liver, kidneys, heart, and spleen. The gall bladder is peeled off the liver starting from the duct.

Splitting and quartering the carcass. From the tailhead down to the neck the carcass is split at the back with the axe or sawed at the vertebrae. If refrigerating facilities are available, the carcass at this time is chilled in the cooling room for at least 24 hours. Chilled meat satisfies a special trade for "ripened" pork. The hog carcass is divided into four wholesale parts or quarters (fig. 9) viz., the head and neck, fore quarter, body, and hind quarter. The fore quarter is separated from the body between the fourth and fifth ribs, the body from the hind quarter at the point where the pelvic bone starts to rise, the remaining portion being the hind quarter.

Retail cuts. Data from the College of Agriculture gave, for the head and neck of a marketable yearling Berkjala barrow weighing 84 kgm. and dressing 66.6 kgm., the amount of 6.8 kgm. which is almost 10 per cent of the total dressed weight. This cut is sold either whole or in halves. From it may be secured the tongue, brain, lean, and fat. The bones may be boiled for soup stock.

The fore quarter yielded 17.8 kgm. or 27 per cent of the dressed carcass. Based on the weight of this cut, 50 per cent was in the form of shoulder butt, 39.0 per cent shoulder, and 11.0 per cent fore shank.

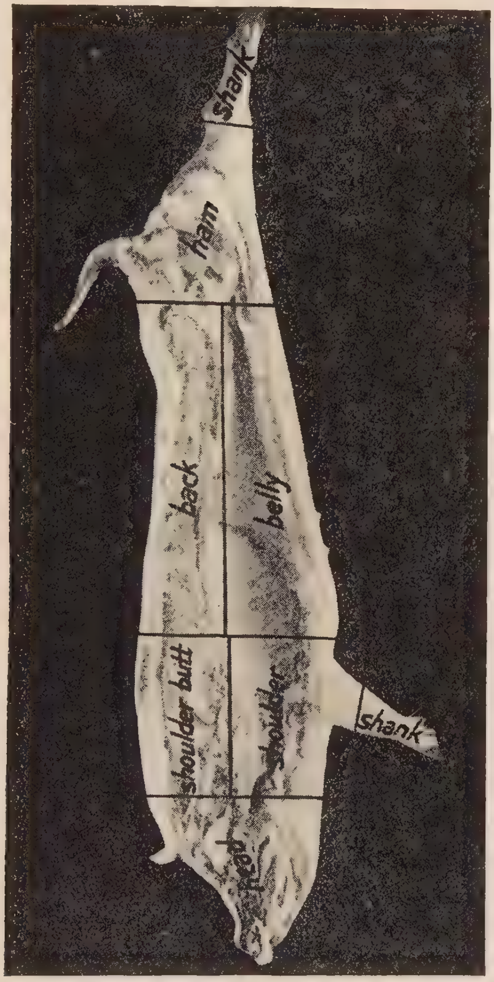

Fig. 9.—One-half of a hog carcass showing wholesale cuts.

The body weighed 25.2 kgm. or 38.0 per cent of the dressed weight. This is further sub-divided into four principal parts: the back, which is 40.0 per cent of the body, the belly, 50 per cent, and the leaf fat, 10.0 per cent. The back consisted of 15.0 per cent of fat back, 45.0 per cent of pork chops, and 40.0 per cent of loin roast. The pork chops are separated from the loin roast between the last two ribs.

The hind quarter weighed 16.8 kgm., which is 25 per cent of the dressed weight. The percentages of retail cuts from this were: rump, 13.0 per cent; ham, 72.0 per cent; and hind shank, 15.0 per cent.

Of all the cuts, pork chops, loin roast, and ham are considered the best and should command higher prices than the other cuts. The head, neck, and shanks are cheap cuts, the rest being ordinary cuts.

The blood and entrails of pigs are usually in big demand. The liver is greatly esteemed and is sold at the same price as ordinary cuts. The rest is sold for the making of a local food preparation called *dinuguan.*

Unsold meat as well as the trimmings are utilized to advantage by being converted into sausage. Following is a simple recipe which finds general acceptance among consumers. For every kilogram of ground meat 22.5 grams of salt, 3 grams of ground pepper and 4 grams of *pimenton,* red pepper are mixed. Vinegar, lemon juice, garlic, onion and spices such as sage, allspice, cinnamon, cloves, and nutmeg may be added to suit individual taste. The mixture is placed in casings and may be smoked or not before cooking.

Dressing percentage. On the whole, Berkjala pigs slaughtered at the College of Agriculture give an average dressing percentage of 73.2 per cent. Well-finished, yearling barrows of the same breed give an average of 79.2 dressing percentage.

SHEEP AND GOATS

Mutton and chevron are much discriminated against by the general public in the Philippines. In certain regions of the country, however, the people have acquired a traditional liking for these kinds of meat so that in their special celebrations chevron or mutton is almost invariably included in their food preparations. The cultivation of taste for these meats should be made general. In this way, greater consumption of meat would be stimulated.

How to kill. First, with the butcher standing on the right side of the animal, the left fore shank is grasped and brought towards him thus throwing the animal on its left side. The operator now places himself towards the back of the animal. The head of the animal is slightly pressed downward by his left hand while the body is held down by his knee which is placed on the shoulder. The point of the knife, with the blade directed away from the butcher, is then thrust into the throat of the animal between the head and neck next to the ear. The knife is carried outwardly thus cutting through the blood vessels, throat and skin. Blood spurts out in copious amounts resulting in sudden death of the animal. The blood is collected in a clean pan which is placed below the cut portion of the neck. As much blood as can possibly be drained from the body of the animal should be removed by raising its shoulder now and then.

Removing the skin. With the gambrel on the hind legs of the animal, the body is hoisted up. The skin is cut around the shank at the lower joint of the hock. Then it is cut inside from the hock straight to the inguinal region. The same is done on the other side. A cut is now made at the middle of the body from the rectum to the neck. A circular cut is also made below the knees and from here to the brisket a straight cut is made inside each leg. From the legs, the skin is separated a short distance on each side of the initial cuts by means of the knife. Then the closed fist of the hand is worked over between the loose skin and flesh of the carcass, this method of skinning being known as knuckling. This is done all over except at the sides where lean tissues are firmly attached to the skin. The knife is used here instead.

Dropping the entrails. The brisket is first opened by sawing. From here the cut is extended downward to the end of the neck. Then a cut is made around the rectum which is tied before it is released. An opening is now started at the inguinal region down to the brisket. The diaphragm is then separated from the ribs thus allowing the internal organs, except the kidneys, to drop down. The kidneys are pulled off later.

Partitioning the carcass into wholesale cuts (fig. 10). The carcass is sawed at the center of the vertebrae from the tailhead to the neck. Then, between the 12th and last rib the carcass is cut, thus partitioning it into the fore saddle and hind saddle. The fore saddle consists of the hotel rack, chuck and breast, and the hind saddle, legs, loin and flanks. The average percentages of various wholesale cuts in the sheep and goat carcasses[3] follow: Chuck, including neck,

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[3] GATAN, A. M. A comparative study on the amount and proportion of edible and non-edible portions in the different wholesale cuts of wethers and wether goats at one and a half years of age. (Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Science in Agriculture, 1937. Unpublished).

24.6 per cent in sheep, 23.6 in goats; hotel rack, 12.6 per cent in sheep, 10.7 per cent in goats; loin, 11.7 per cent in sheep, 9.6 per cent in goats; breast, including shanks, 15.6 per cent in sheep, 18.3 per cent in goats; legs, 31.4 per cent in sheep, 35.1 per cent in goats; flanks, 4.2 per cent in sheep, 2.7 per cent in goats.

Choice cuts. The loin and leg are valuable cuts. They may be used as roasts or steaks. The leg possesses a large percentage of lean while the muscle fibers of the loin are tender. The hotel rack also gives good cuts that may be used for chops or roasts.

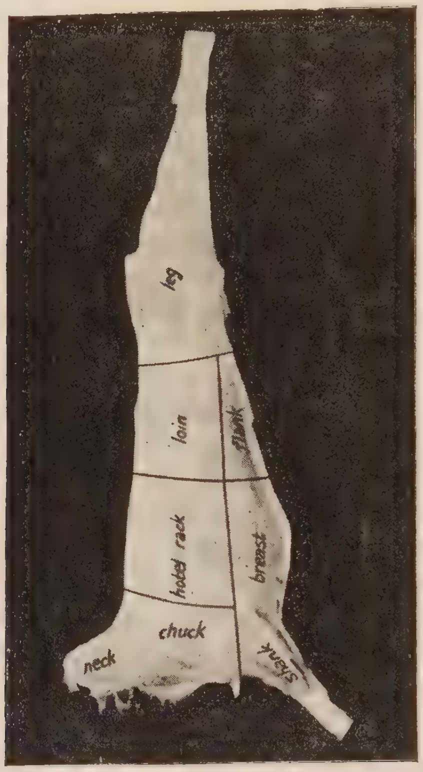

Fig. 10.—Sheep carcass showing meat cuts.

Ordinary cuts. The rest of the cuts like the chuck, breast, and flank are used for stews although with big and fat carcasses they may be cooked as roasts, steaks, or chops.

Internal organs. As a rule, the internal organs, with the exception of the liver, heart, and kidneys, are disposed of as waste. The liver is highly esteemed. In northern Luzon, the intestines are saved and made into a special preparation.

Comparative weights of dressed carcass and dressing percentages of sheep and goats.[4] Studies have been made at this College on the proportion of edible to non-edible portion of the dressed carcasses, as well as the dressing percentages, of wethers and wether goats at one and a half years of age. At this age the animals were considered large enough to yield carcasses of good size, yet possessing lean tissues which were tender and of fine texture. Grade Indian sheep and grade Anglo-Nubian goats were used. The results of these studies showed that the average dressed weight of sheep was 16.5 kgm. and of goats 11.4 kgm. The average dressing percentage was 51.3 in sheep and 51.4 in goats.

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[4] GATAN, A. M. (1937) Op. cit.

VOCATIONAL EDUCATION STUDIES: II. OCCUPATIONAL BACKGROUND AND VOCATIONAL INTERESTS OF GRADE VII PUPILS[1]

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The results of a survey of the occupational background and vocational choice of 1,151 seniors in nine public high schools appeared in March, 1938. A similar study among the Grade VII pupils should prove of importance. The seventh grade is the period when a pupil makes his decision regarding the type of secondary education he would pursue. It is an opportune time for vocational and educational guidance. At this point the interest of the boys and girls should be known in order that proper advice may be given as to the nature of education they should pursue to prepare them for the type of occupations that will fit their native capacity and aptitude, inasmuch as the high school is ordinarily considered the place where a large number is prepared for the common occupations. The high school is the university of the masses, for only a relatively small proportion of pupils go beyond the secondary school.

Objects of the present survey

The objects of this survey were: (a) to get a knowledge of the distribution of occupations in the district surveyed through a study of the vocations of parents of Grade VII pupils, (b) to know the educational intentions of pupils in the seventh grade, (c) to discover their vocational interests, and (d) to determine the proportion of pupils selecting a life work similar to that of their parents.

MATERIALS AND METHODS

This survey includes 1,040 Grade VII pupils in different elementary schools located in a region composed of five provinces: namely, Batangas, Cavite, Laguna, Rizal, and Tayabas. A questionnaire was prepared and copies were sent to different school principals, who distributed them among the pupils about one month before the close of the school year. The questionnaires were afterwards returned to the writer. The pupils included in the report were candidates for graduation either in March, 1935, or in March, 1936.

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[1] Experiment Station contribution No. 1280.

RESULTS AND DISCUSSION

The results of this survey are given in tables 1 to 7.

Sex of pupils and their intention of going to high school

Table 1 shows that of the 1,040 Grade VII pupils, 671, or 64.5 per cent, were males. In nine academic high schools, the author (1938) found that boys comprised 69.5 per cent of the senior classes.

Table 1 also shows that 68.2 per cent intended to go to the high school, 29.2 per cent did not intend to do so, and 2.6 per cent were doubtful. Among the high school seniors, a previous study revealed that 77.5 per cent intended to go to college.

The proportion of boys who wanted to go to high school was larger than that of girls. A similar tendency was previously discovered in the case of high school seniors.

Occupations of parents

Table 2 gives the occupations of fathers of Grade VII pupils included in this survey. Sixty-three types of occupations are represented, as compared with twenty-two in the case of parents of high school seniors reported by the author (1938). This may show that the attendance in the elementary school is not restricted to certain social groups as in the high school. Some of the occupations not found in the list of pursuits of parents of high school seniors were: blacksmith, woodcutter, water carrier, janitor, shoe and slipper maker, wooden shoe maker, truck conductor, optician, sheriff, tax collector, mason, and interpreter. One must keep in mind, however, the fact that only a few people are engaged in some of these pursuits, and, therefore, the absence of parents of high school seniors from these occupational groups may be due to fewness rather than to economic inability to finance their children's high school education.

The percentages of parents engaged in the more common occupations and in professional work are given in table 2. The figures show that farming and business are important occupations; hence, a large number should be trained for these pursuits.

While only 48.5 per cent of the fathers of Grade VII pupils were in farming or in business, 72.9 per cent of parents of high school seniors were engaged in these pursuits (Sacay, 1938). This may indicate that farmers and businessmen are usually financially able to send their children to higher institutions of learning.

Choice of curricula

The curricula chosen by the Grade VII pupils intending to go to the high school are shown in table 3.

If this decision is followed, it will be an evidence of the increasing popularity of vocational courses. The Bureau of Education reported that in 1936 about 67 per cent of the high school students were enrolled in the academic curriculum. The pupils selecting the commercial curriculum is only a very small proportion, considering the large proportion of parents engaged in this pursuit.

Occupational choice of Grade VII boys

The occupational choice of Grade VII boys may be seen in table 4. A total of 39 occupations was represented. The number reported in the case of high school seniors was 37. A further comparison between the two groups of students reveals that a greater percentage of the Grade VII boys chose farming and the more common occupations.

The proportion intending to become farmers is much bigger in the case of Grade VII boys who did not intend to continue schooling, the percentage being 46.2, than that for boys intending to continue which was 28.8 per cent. The choice of those not intending to secure higher education was limited to a few vocations. Besides farming, a large number intended to become merchants, shoe makers, mechanics, soldiers, tailors, laborers, fishermen, and musicians.

Occupational choice of female pupils

The occupational interests of girls are shown in table 5. Half of the girls who intended to pursue further education chose teaching and dressmaking. The others wanted to become nurses, housekeepers, pharmacists, merchants, pianists, dentists, and agriculturists. The rest wanted to become doctors, lawyers, chemists, stenographers, hairwavers, and hat weavers.

The choice of occupations of the girls who did not intend to continue their studies was limited to those of the dressmakers, housekeepers, storekeepers, and slippermakers. The choice of the rest was confined to five occupations.

Only eighteen occupations were selected by the girls studied. This number was much less than that chosen by the male pupils. In the case of high school girls, a previous study showed that 26.4 per cent selected teaching; 18.7 per cent, nursing; and 13.6 per cent, homemaking (Sacay, 1938).

Comparison of parents' occupations and male pupils' choice

It was discovered that although many fathers were engaged in a certain occupation, only a few Grade VII boys selected that pursuit. On the other hand, certain occupations, in which few parents were engaged, were selected by a large number of pupils. In some vocations, however, the percentage of parents engaged and percentage of male pupils choosing were nearly the same. In table 6 the different occupations have been classified into these three groups.

Among those in the first group are included the following: laborers, chauffeurs, fishermen, clerks, agents, barbers, blacksmiths, goldsmiths, photographers, policemen, and bakers.

The occupations in the second group were: carpenters, mechanic, soldiers, engineers, teachers, physicians, lawyers, painters, musicians, and aviators.

Farming, business and shoemaking are good examples of occupations in the third group. The other occupations in this group were: shoemakers, employees, tailors, butchers, ministers, sailors, sanitary inspectors, dentists, and foresters.

Proportion intending to follow parents' occupation

The eleven leading occupations in which a large number of fathers were engaged and the occupations chosen by their sons are given in table 7. Of the sons of farmers 54.5 per cent wanted to become farmers. This is much higher than the 25.6 per cent previously reported in the case of high school seniors (Sacay, 1938). A large portion of the remaining half wanted to become merchants, carpenters, teachers, mechanic, and engineers.

Of the sons of merchants, 20.5 per cent chose their parents' occupation. This is close to the 20 per cent reported in the case of high school seniors. The percentages of sons wanting to follow their parents' pursuits were: physicians, 62.5; shoemakers, 43.6 per cent; carpenters, 34.3; fishermen, 25.0; chauffeurs, 17.6; laborers, 5.6; teachers, 0; and clerks, 0 per cent.

SUMMARY

1. Of the 1,040 Grade VII pupils studied, 64.5 per cent were males and 35.5 per cent, females.

2. The proportion intending to pursue further education was: male, 72.9 per cent; female, 59.6 per cent; both sexes, 68.2 per cent.

3. The parents of these pupils were engaged in 63 different occupational groups. The more important ones were: farmers, 34.6

per cent; merchants, 13.9; shoemakers, 5.8; and carpenters, 4.6. Only 3.6 per cent were engaged in the professions of law, medicine, engineering, pharmacy, and dentistry.

4. The proportion of pupils intending to pursue the academic high school curriculum was: male, 46.0 per cent; female, 70.9 per cent; both sexes, 53.7 per cent. Of the males, 23.3 per cent selected the agricultural curriculum and 28.7, the trade.

5. Of the male pupils intending to go to high school, 28.8 per cent intended to become farmers; 10.8, merchants; 9.1, carpenters; 6.9, soldiers; 6.9, engineers; 6.4, mechanics; 6.2, teachers. Those not intending to pursue further education wanted to become: farmers, 46.2 per cent; shoemakers, 11.7; merchants, 8.2; mechanics, 5.8; carpenters, 5.3; and tailors, 4.1.

6. The vocational choice of the female pupils intending to acquire higher education was: teaching, 27.3 per cent; dressmaking, 24.1; nursing, 18.2; housekeeping, 8.2; pharmacy, 6.4; and storekeeping, 4.1 per cent. Those not intending to continue their studies selected: dressmaking, 43.1 per cent; housekeeping, 24.1; and storekeeping, 15.5 per cent.

7. While only a few parents were engineers, mechanic, soldiers, teachers, lawyers, and physicians, a large proportion of pupils selected these occupations. On the other hand, a relatively small number selected occupations in which many parents were engaged, such as those of fisherman, clerk, agent, barber, blacksmith, baker, and policeman.

8. A fairly large proportion of sons of physicians, farmers, shoemakers, and carpenters wanted to follow their parents' vocation. In the other occupations, the proportion ranged from 0 to 25 per cent.

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TABLE 1

Number of Grade VII pupils studied, their sex, and their intention of going to high school

	MALE	FEMALE	TOTAL
Number of pupils	671	369	1,040
Percentage	64.5	35.5	100.0
Intending to go to high school	489	220	709
Not intending	165	139	304
Doubtful	17	10	27
Percentage intending to go to high school	72.9	59.6	68.2
Percentage not intending to go to high school	24.6	37.7	29.2
Percentage doubtful	2.5	2.7	2.6

TABLE 2

Occupation of parents of Grade VII pupils

OCCUPATION	MALE		FEMALE		TOTAL	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*
Farmers, agriculturists	244	38.9	86	26.4	330	34.6
Merchants, businessmen	78	12.4	54	16.6	132	13.9
Shoemakers, slippermakers	39	6.2	16	4.9	55	5.8
Carpenters	29	4.6	15	4.6	44	4.6
Proprietors	13	2.1	31	9.5	44	4.6
Chauffeurs, drivers	17	2.7	8	2.5	25	2.6
Unskilled laborers	18	2.9	6	1.9	24	2.5
Fishermen	16	2.6	8	2.5	24	2.5
Employees	11	1.7	11	3.4	22	2.3
Teachers, supervisors	10	1.6	7	2.1	17	1.8
Tailors	9	1.4	8	2.5	17	1.8
Clerks, stenographers	9	1.4	6	1.9	15	1.6
Agents	7	1.1	7	2.1	14	1.5
Barbers	7	1.1	5	1.5	12	1.3
Physicians	8	1.3	4	1.2	12	1.3
Policemen	5	0.8	6	1.9	11	1.2
Pharmacists	5	0.8	4	1.2	9	1.0
Mechanic	6	1.0	3	0.9	9	1.0
Blacksmiths	7	1.1	1	0.3	8	0.8
Foremen	7	1.1	1	0.3	8	0.8
Goldsmiths, silversmiths	6	1.0	1	0.3	7	0.7
Business managers, directors	6	1.0	1	0.3	7	0.7
Musicians	4	0.6	2	0.6	6	0.6
Butchers	6	1.0	—	—	6	0.6
Lawyers	3	0.5	3	0.9	6	0.6
Municipal treasurers	3	0.5	3	0.9	6	0.6
Municipal presidents, vice-presidents	3	0.5	2	0.6	5	0.5
Photographers	5	0.8	—	—	5	0.5
Dentists	2	0.3	2	0.6	4	0.4
Bakers	3	0.5	1	0.3	4	0.4
Soldiers	3	0.5	1	0.3	4	0.4
Ministers, religious workers	3	0.5	1	0.3	4	0.4
Sailors, justices of the peace, cooks, painters, water-carriers, postmasters, municipal secretaries, sanitary inspectors, engineers (3 each)	14	2.2	13	4.0	27	2.9
Wooden-shoe makers, forest guards, notaries public, surveyors, rice-mill operators, truck conductors, building contractors, members of provincial board (2 each)	11	1.7	5	1.5	16	1.7
Bookkeeper, herbalist, soap maker, optician, metal worker, sheriff, tax collector, railroad inspector, wood cutter, mason, interpreter, leather cutter, janitor, electrician (1 each)	10	1.6	4	1.2	14	1.5
Total	627	100.0	326	100.0	953[a]	100.0

[a] 87 dead or occupation not given.

TABLE 3

Curricula chosen by Grade VII pupils intending to go to high school

CURRICULA	BOYS		GIRLS		TOTAL	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*
Academic	225	46.0	156	70.9	381	53.7
Trade	140	28.7	8	3.6	148	20.9
Agricultural	114	23.3	7	3.2	121	17.1
Home economics	—	—	32	14.5	32	4.5
Commercial	3	0.6	—	—	3	0.4
Miscellaneous	6	1.2	3	1.4	9	1.3
No reply	1	0.2	14	6.4	15	2.1
Total	489	100.0	220	100.0	709	100.0

TABLE 4

Occupational choice of Grade VII boys

OCCUPATION	INTENDING TO GO TO HIGH SCHOOL		NOT INTENDING OR DOUBTFUL		TOTAL	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*
Farmers, poultry raisers, etc.	139	28.8	79	46.2	218	33.4
Merchants, businessmen	52	10.8	14	8.2	66	10.1
Carpenters	44	9.1	9	5.3	53	8.1
Mechanic	31	6.4	10	5.8	41	6.3
Soldiers	33	6.9	3	1.7	36	5.5
Engineers	33	6.9	—	—	33	5.0
Teachers	30	6.2	—	—	30	4.6
Shoemakers	8	1.7	20	11.7	28	4.3
Physicians	20	4.2	—	—	20	3.1
Painters	15	3.1	2	1.2	17	2.6
Lawyers	15	3.1	—	—	15	2.3
Musicians	10	2.1	4	2.3	14	2.1
Aviators	12	2.5	—	—	12	1.8
Tailors	2	0.4	7	4.1	9	1.4
Employees	6	1.3	1	0.6	7	1.1
Laborers	—	—	7	4.1	7	1.1
Chauffeurs, drivers	4	0.8	1	0.6	5	0.8
Fishermen	1	0.2	4	2.3	5	0.8
Sailors	3	0.6	1	0.6	4	0.6
Blacksmiths	3	0.6	—	—	3	0.4
Contractors	—	—	3	1.7	3	0.4
Butchers	1	0.2	2	1.2	3	0.4
Goldsmiths	1	0.2	1	0.6	2	0.3
Agents	—	—	1	0.6	1	0.2
Photographers	—	—	1	0.6	1	0.2
Foresters, miners, chemists, pharmacists, ministers, detectives, sanitary inspectors (2 each)	14	2.9	—	—	14	2.2
Clerk, dentist, nurse, electrician, radio operator, postmaster (1 each)	5	1.0	1	0.6	6	0.9
Total	482	100.0	171	100.0	653	100.0

TABLE 5

Occupational choice of female pupils

OCCUPATION	INTENDING TO GO TO HIGH SCHOOL		NOT INTENDING OR DOUBTFUL		TOTAL	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*
Dressmakers, modistes	53	24.1	50	43.1	103	30.6
Teachers	60	27.3	1	0.9	61	18.1
Housekeepers	18	8.2	28	24.1	46	13.7
Nurses	40	18.2	2	1.7	42	12.5
Merchants, storekeepers	9	4.1	18	15.5	27	8.0
Pharmacists	14	6.4	—	—	14	4.2
Slippermakers, shoemakers	—	—	12	10.3	12	3.6
Pianists, musicians	7	3.2	—	—	7	2.1
Dentists	5	2.3	—	—	5	1.5
Agriculturists	3	1.3	1	0.9	4	1.2
Laborers	—	—	3	2.6	3	0.9
Doctors	2	0.9	—	—	2	0.6
Lawyers	2	0.9	—	—	2	0.6
Chemists	2	0.9	—	—	2	0.6
Stenographers	2	0.9	—	—	2	0.6
Hair-wavers	2	0.9	—	—	2	0.6
Clerk	—	—	1	0.9	1	0.3
Hat weaver	1	0.4	—	—	1	0.3
Total	220	100.0	116	100.0	336	100.0

TABLE 6

Classification of occupations based on proportion of fathers engaged as compared to number of male pupils selecting same

NATURE OF OCCUPATION	OCCUPATION OF FATHERS		CHOICE OF GRADE VII PUPILS	
	number	*per cent*	*number*	*per cent*
I. Laborers	18	2.9	7	1.1
Chauffeurs, drivers	17	2.7	5	0.8
Fishermen	16	2.6	5	0.8
Proprietors	13	2.1	—	—
Clerks, stenographers	9	1.4	1	0.2
Agents	7	1.1	1	0.2
Barbers	7	1.1	—	—
Blacksmiths	7	1.1	3	0.4
Foremen	7	1.1	—	—
Goldsmiths	6	0.9	2	0.3
Pharmacists	5	0.8	2	0.3
Photographers	5	0.8	1	0.2
Policemen	5	0.8	—	—
Bakers	3	0.4	—	—
Miscellaneous	33		13	
II. Mechanic	6	0.9	41	6.3
Soldiers	3	0.4	36	5.5
Engineers	3	0.4	33	5.0
Teachers	10	1.6	30	4.6
Physicians	8	1.7	20	3.1
Painters	3	0.4	17	2.6
Lawyers	3	0.4	15	2.3
Musicians	4	0.6	14	2.1
Aviators	—	—	12	1.8
III. Farmers	244	38.9	218	33.4
Merchants, businessmen	78	12.4	66	10.1
Shoemakers	39	6.2	28	4.3
Carpenters	29	4.6	53	8.1
Employees	11	1.7	7	1.1
Tailors	9	1.4	9	1.4
Sailors	3	0.4	4	0.6
Butchers	6	0.9	3	0.4
Ministers	3	0.4	2	0.3
Foresters	2	0.3	2	0.3
Sanitary inspectors	3	0.4	2	0.3
Dentists	2	0.3	1	0.2

TABLE 7

Relation between fathers' occupations and sons' choice

CHILDREN'S CHOICE	OCCUPATION OF FATHER										
	Farmers	Merchants	Shoemakers	Carpenters	Laborers	Employees	Chauffeurs, drivers	Firshermen	Clerks	Physicians	Teachers
Farmers	133	19	5	9	4	1	3	4	2	—	4
Merchants	21	16	3	—	2	1	3	1	2	1	1
Shoemakers	—	7	17	—	—	—	—	—	—	—	—
Carpenters	16	5	1	10	—	—	1	2	—	1	1
Laborers	3	—	1	—	1	—	—	—	—	—	—
Chauffeurs, drivers	2	—	—	—	—	—	3	—	—	—	—
Fishermen	—	—	—	—	1	—	—	4	—	—	—
Physicians	4	4	—	—	1	2	—	—	—	5	—
Teachers	10	7	—	1	—	2	1	—	1	—	—
Engineers	9	4	1	1	1	1	—	1	—	1	—
Mechanic	8	3	1	1	1	—	3	1	2	—	2
Lawyers	5	2	—	—	1	—	2	—	—	—	—
Soldiers	4	2	5	—	2	2	1	2	2	—	—
Musicians	3	2	2	—	1	—	—	—	—	—	—
Sailors	1	—	—	—	—	—	—	—	—	—	1
Painters	2	2	2	—	2	—	—	—	—	—	—
Artists	—	1	—	1	—	—	—	—	—	—	—
Aviators	—	1	—	1	—	1	—	—	—	—	1
Clerks	1	—	—	—	—	—	—	—	—	—	—
Miscellaneous	22	3	1	5	1	1	—	1	—	—	—
Total	244	78	39	29	18	11	17	16	9	8	10
Per cent selecting fathers' occupation	54.5	20.5	43.6	34.3	5.6	—	17.6	25.0	—	62.5	—

A PRELIMINARY REPORT ON THE PERFORMANCE OF TEN RICE VARIETIES FROM THE FEDERATED MALAY STATES[1]

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Of the Department of Agronomy

WITH FOUR TEXT FIGURES

One of the ways for improving rice yield is by introduction and acclimatization of foreign varieties. In plant introduction, however, an efficient quarantine service is necessary in order to prevent the entrance and establishment of dangerous pests and diseases.

That the introduction of foreign rice varieties has, to a certain extent, helped the improvement of rice production in the Philippines is shown by the fact that some of our outstanding varieties, especially the Ramai, Elon-elon, Khao Bai Sri, and others of less importance, were introduced into these Islands.

A review of rice importation from foreign countries and acclimatization tests in the College of Agriculture

According to Mendiola (1919),[2] the first importation of rice varieties in the College of Agriculture was made on March 13, 1913. Forty-six varieties were obtained from Bombay, India; California, the United States; Batavia, Java; Formosa; and Portuguese India.

In addition to the number reported by Mendiola (1919), the College of Agriculture received sixteen varieties from California in 1923, forty-four from Java from 1924 to 1927, and five from Peru in 1938. Mendiola also states that little has been reported on results of these rice importations because only one planting was made. These meager reports, however, show that although these varieties seemed to mature early, they were variable as to time, were apparently more adapted to lowland than to upland conditions, and had a very marked tendency to tiller.

On December 3, 1930, varieties Pinkeo, Koa Todlong, Nam Dogmai, Nang Tani, Bang Phra, and Champason, were introduced from Siam into this College by Swasdi Viradeja. Field tests on these varieties were conducted from 1931 to 1934 by thesis students[3] of this College. The results of the three-year-trial plantings indicated that of the six imported varieties Nang Tani was the most promising as may be seen in the following table:

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[1] Experiment Station contribution No. 1281. Read by the junior author before the Los Baños Biological Club on June 30, 1938.

[2] MENDIOLA, N. B. 1919. A review of the rice investigations at the College of Agriculture. The Philippine Agriculturist 8: 145-160.

VARIETIES	1931-32		1932-33		1933-34	
	Yield	Maturity	Yield	Maturity	Yield	Maturity
	cavans	*days*	*cavans*	*days*	*cavans*	*days*
Pinkeo	10.80	144	32.32	158	31.77	158
Koa Todlong	22.10	136	7.01	153	40.04	154
Nam Dogmai	18.17	161	44.23	160	48.96	167
Nang Tani	18.66	162	59.87	167	82.82	166
Bang Phra	12.28	156	26.26	162	38.82	156
Champason	17.68	139	21.25	163	36.59	155

As a result of these tests, Nang Tani has since been planted on a large scale in the College lowland rice fields; in the municipalities of Bigaa and Calumpit, Bulacan; and Sta. Rosa, San Jose, and Aliaga, Nueva Ecija. The other varieties were dropped from the College cultures because of their low average yield.

On July 27, 1934, varieties No. 75, No. 79, Kalyaman, Lead, Ramkajara, Blue Stick, and Demerara Creole were received by Dean B. M. Gonzalez from British Guiana. These were planted in the lowland rice fields of the Experiment Station in the same year and the results of the first year of trial test are as follows:[4]

VARIETY	DAYS OF MATURITY	AREA OF PLOT	ACTUAL YIELD OF PLOT	COMPUTED YIELD PER HECTARE
		sq. m.	*kgm.*	*cavans*
No. 75	136	94.17	22.8	55.02
Kalyaman	132	79.04	16.0	45.98
Lead	138	132.76	17.8	30.47
Ramkajara	136	100.00	6.0	13.63
Demerara Creole	140	72.50	10.0	31.34
No. 79	135	50.00	6.4	29.09

The data above show that varieties No. 75 and Kalyaman, were promising. After three years of trial test, however, these two varieties proved of little value because they had a very poor tillering quality, seldom grew higher than 60 centimeters, and bloomed so early that they were subject to attacks of insect pests. Owing to these qualities, the yields were very low. When tried under upland conditions, they also proved of little value; hence, they were dropped from the College cultures.

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[3] Data presented have been obtained from theses presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture by Swasdi Viradeja, 1932; Genaro M. Baquiran, 1933; and Gregorio Jaime, 1934.

[4] The data on yield of the different varieties were taken from the Annual Report of the Division of Annual Farm Crops, Department of Agronomy, College of Agriculture, for the year 1934-35.

On October 21, 1934, Dr. N. B. Mendiola received nine varieties of rice from Kwangtung, China. These were planted in cans of soil in July, 1935, but none of them germinated.

The present paper is a preliminary report of the results of two years of trial plantings of ten varieties of lowland rice obtained from the Department of Agriculture of the Federated Malay States at Kuala Lumpur. The seeds were secured by Mr. Marcelino G. Canlas, who was Assistant Chief of the South Siam Agricultural Experiment Station at Haad Yai, Siam. They were received on June 6, 1936, and were planted in seed beds in August of the same year.

MATERIALS AND METHODS

Rice varieties studied

According to the Experiment Station at Kuala Lumpur, the cultural requirements and performance in the Federated Malay States of each of the ten varieties of lowland rice studied are as follows:

a. Reyong 20. This variety is of recent selection in Kedah. It is suitable to conditions where water is available during the growth period. It matures in about six months from the time it is sown in the seed bed, and yields about 3,000 pounds per acre or 76.46 cavans per hectare. It has a good milling quality.

b. Siam 29. This variety is grown successfully in many parts of Malaya, except where the soil is deep, soft, and extensively rich, under which conditions, it lodges readily. It matures in about six and one half months including the seedling period, and yields about 65.04 cavans per hectare.

c. Mayang Ebos 203. This is a recent selection but a promising variety. It is suitable to average lowland conditions and matures in about six months including the seedling period.

d. Seraup Besar 15 (Sakapol). Deep soil and plenty of water is preferred by this variety. In exceptionally rich soil, however, it has a tendency to lodge. It matures in about eight months and yields about 68.63 cavans per hectare.

e. Seraup Kechil 36. Like Seraup Besar 15, this variety requires deep rich soil and adequate water. It matures in about eight months from the seedling period and yields about 68.63 cavans to the hectare under average conditions.

f. Seraup Kechil 146. This variety is of recent selection in Krian (North Perak). It is suitable to deep rice land with adequate irrigation facilities. Under such conditions, it yields about 82.87 cavans per hectare and matures in eight to eight and one-half months including the seedling stage.

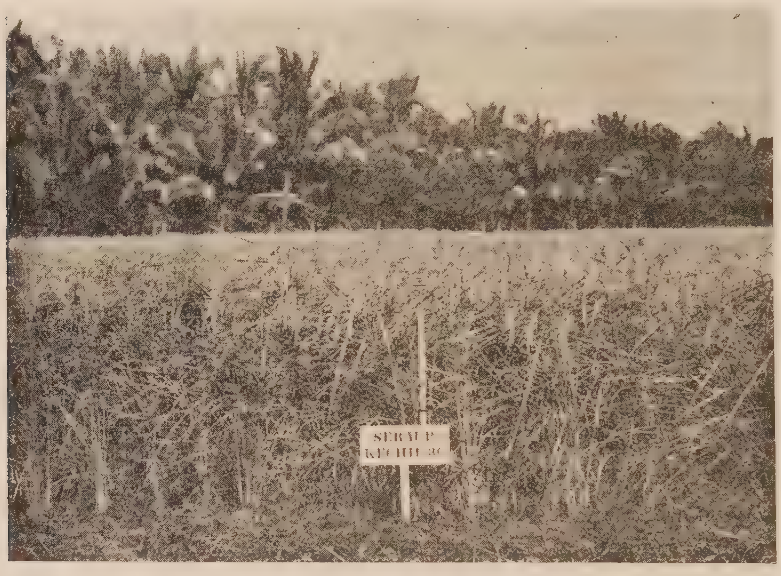

Fig. 1.—Stand of plants one week before harvesting.

g. Radin 2. This is a variety suitable to medium heavy soil and fairly resistant to a deficiency in water supply; it matures in from six to six and one-half months and yields about 64.88 cavans per hectare under average conditions.

h. Radin China 4. Like Reyong 20, Radin China 4 is a recent selection in Kedah, generally with good yielding characters. It grows very well in good clay soil with sufficient water during the growth period, matures in about six and one-half months, and yields about 76.48 cavans per hectare.

i. Radin Siak 24. This variety is chiefly useful when a short season crop is desired. It is not a very good yielder but will withstand shortage of water. It matures in about six months and gives about 48.4 cavans per hectare.

j. Nachin 66. This is a selection from Malacca where it has gained popularity. It is adapted to heavy clay soil with adequate water. Under average conditions, it yields about 57.39 cavans per hectare and matures in about six and one-half to seven and one-half months from the time it is sown in the seed bed.

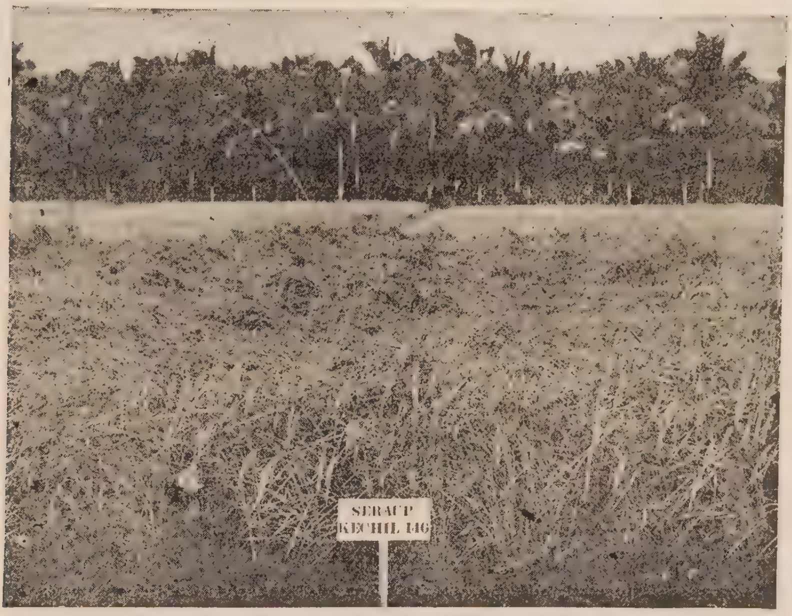

Fig. 2.—Stand of plants one week before harvesting. Note tendency of plants to lodge.

All the harvests from each variety during the first year were used as seed in the second year.

The land

In the first year, these varieties were planted in a portion of the lowland rice fields in the Experiment Station of the Department of Agronomy. Each variety occupied only one plot because there was at first very little seed. The land used in the second year was another portion of the lowland rich fields in the Experiment Station.

From three to eight replications were made with each of the different varieties.

Each plot was a rectangle with an area varying from 152 to 715 square meters so that all the seeds available could be planted.

Cultural methods

Preparation of seed bed. The different varieties were sown separately in seed beds prepared by plowing in July when the soil was soft. Water was turned into the plowed paddy to saturate the soil. The fields were harrowed crosswise and lengthwise four days after plowing, after which the bed was again irrigated and left for about five days to allow the weeds to decay. The land was again harrowed for the third time, thoroughly puddled, and levelled.

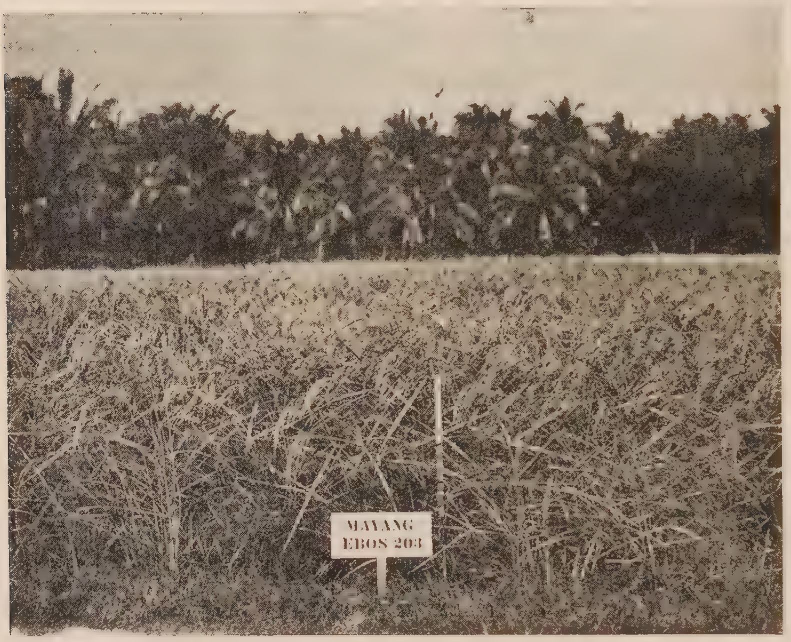

Fig. 3.—Stand of plants one week before harvesting.

Preparation of the field. As in the preparation of the seed bed, the field for transplanting was plowed thoroughly. The openings in the dikes were closed and water was turned into the paddies. A few days later, the fields were harrowed lengthwise and water was turned into the paddies again in order to kill the weeds. About a week after the first harrowing, a crosswise harrowing followed.

Water was again turned into the paddies in order that the weeds would decay thoroughly, and the fields were left untouched for another week. After one week, the paddies were thoroughly puddled and levelled for planting.

Planting. The original seeds of the ten varieties of rice were sown separately in seed beds on August 2, 1936. The seedlings were transplanted 31 days later when they were about 30 centimeters high. In the second year, the seeds were sown on August 6, 1937, and the seedlings were transplanted from September 14 to 20, 1937, thirty-nine to forty-five days after sowing when they were about forty-five centimeters high. In both years, the seedlings were transplanted, three to a hill and about twenty centimeters apart.

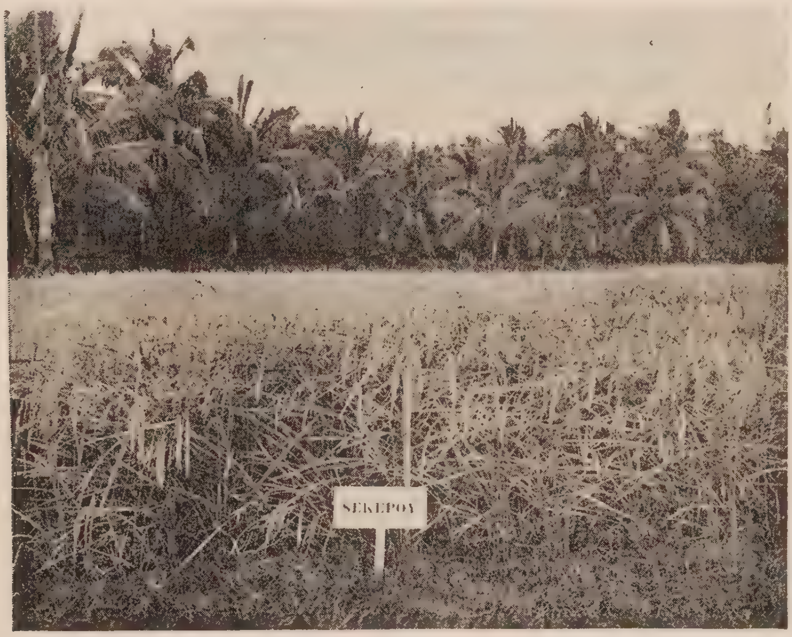

Fig. 4.—Stand of plants one week before harvesting. Sekepoy is another name for Seraup Besar 15 (Sekepoy).

Care of the plants

In the first year, the transplanted seedlings were irrigated and thoroughly weeded until about the flowering stage. In the second year, when the different varieties were grown on a bigger scale, the plants were not weeded; and owing to inadequate irrigation facilities, rain was the chief water supply.

Harvesting and threshing

In the first planting, the different varieties were harvested between December 28, 1936 and January 15, 1937; and in the second, between January 10, 1938, and January 28, 1938. The crop was harvested with a native implement, the "yatab". The harvest from each variety was threshed separately with the feet, winnowed, and the weight recorded.

RESULTS AND DISCUSSION

Field observations

Stand and tillering power of the different varieties. From the two years' plantings, it was observed that of the ten varieties planted, the Seraup Kechil 36 and Seraup Kechil 146 were most uniform in height. The tenants of the College of Agriculture were impressed by their good characteristics.

Because the seedlings were not planted one to the hill, the tillering capacity of the different varieties could not be studied accurately. It was observed, however, that of the ten varieties under trial, the Seraup Kechil 146 proved to have a marked tendency to tiller profusely. The Seraup Kechil 36 and Seraup Besar 15 (Sakapol) were two other varieties that showed a rather high tillering power.

Flowering and maturity periods of the different varieties. As shown in table 1, Reyong 20, the earliest variety to mature, required in the first year, 115 days from sowing to flowering, and 148 days from sowing in the seed bed to harvesting. In the second year, however, it flowered in 126 days and was harvested in 154 days after the seeds had been sown. The Seraup Kechil 36, in both plantings, was the last harvested requiring 169 days to mature in the first year and 175 days in the second.

The other varieties in the first planting bloomed in from 117 to 129 days and matured in from 155 to 169 days after being sown. In the second year, most of the varieties matured in 154 days from the time they were sown.

Flowering and maturity of the grains in the different varieties, in general, were fairly uniform, except for a few mixtures apparently different from the varieties under trial, but which might have been mixed with the original seeds. It can be seen further in tables 1 and 2 that in some cases the maturity periods of some of the varieties studied were longer in the second year than in the first.

Lodging characteristics of the different varieties. It was observed from two years' plantings that although some of the varieties had the tendency to lodge, others had stalks that withstood strong winds. The varieties Seraup Kechil 36, Mayang Ebos 203, and Seraup Besar 15 (Sakapol) were found to be fairly resistant to strong winds and stood up to the time they were ready for harvesting (figures 1, 3, and 4). The varieties Siam 29, Radin China 4, Reyong 20, Radin Siak 24, Radin 2, and Nachin 66 had the tendency to lodge. Seraup Kechil 146 was observed to lodge readily (figure 2) with the occurrence of strong winds, especially when the grains were about to mature.

Pests and diseases affecting the crops. No serious pests and diseases attacked the plants during the two years' trial plantings. In the second year, however, damage caused by rats, stem borers, and rice bugs, especially among the earlier maturing varieties was observed. This was possibly because the field planted to these varieties in the second year was adjacent to a coconut plantation where rats may have found shelter and breeding places.

Production of the different varieties under Los Baños conditions

The results of two years' trial plantings of the different varieties are presented in tables 1 to 3. It is evident from table 2 that although some varieties increased their production in the second year, the majority of them decreased. It may be seen in table 3 that the yield of the varieties in their country of origin is very much higher than that in the Philippines. Besides the three heavy yielding varieties mentioned, at least three other varieties, namely, Radin 2, Nachin 66, and Mayang Ebos 203, may be considered promising.

Examination of the maturity period of the different varieties, indicates that they matured very much earlier in the Philippines than in the Federated Malay States. Apparently all of the varieties under trial may be considered as medium late maturing.

SUMMARY AND CONCLUSIONS

From the results of two years' tests of ten different varieties of rice from the Federated Malay States, the following conclusions may be drawn:

1. At least four varieties, namely Seraup Kechil 146, Seraup Kechil 36, Seraup Besar 15 (Sakapol), and Radin 2 may prove promising under Philippine conditions.

2. The different varieties matured very much earlier at Los Baños, Laguna, than in the Federated Malay States.

3. The varieties are not pure lines and need further selection.

4. Seraup Kechil 146 and Seraup Kechil 36 proved to have the best tillering power of all of the varieties studied.

5. Seraup Kechil 36 and Seraup Besar 15 (Sakapol) did not readily lodge, whereas Seraup Kechil 146 lodged easily.

6. No serious insect pests and diseases were found attacking the plants.

TABLE 1

Blooming and maturity periods and yield of different varieties of rice from the Federated Malay States in the first planting

VARIETIES	AREA PLANTED	ACTUAL YIELD PER PLOT	COMPUTED YIELD PER HECTARE	TIME FROM SOWING TO	
				Blooming	Maturity
	sq. m.	*kgm.*	*cavans*	*days*	*days*
Seraup Kechil 36 ...	90.4	31.2	78.43	127	169
Seraup Besar 15	77.52	24.0	70.36	129	166
Seraup Kechil 146 ..	56.00	17.0	68.97	129	166
Radin 2	86.64	19.0	49.84	122	159
Siam 29	91.2	19.4	48.34	117	155
Mayang Ebos 203 ...	67.5	11.2	38.04	129	159
Radin Siak 24	81.0	10.8	30.30	127	155
Reyong 20	108.0	11.1	23.35	115	148
Nachin 66	67.5	4.0	13.46	127	155
Radin China 4	100.0	5.2	11.81	128	160

TABLE 2

Blooming and maturity periods and yield of the different varieties of the Federated Malay States rice in the second planting

VARIETIES	AVERAGE COMPUTED YIELD PER HECTARE	TIME FROM SOWING TO	
		Blooming	Maturity
	cavans	*days*	*days*
Seraup Kechil 146	73.01 ± 0.581	136	175
Seraup Kechil 36	55.38 ± 1.363	136	171
Seraup Besar 15	53.95 ± 2.951	131	169
Nachin 66	46.11 ± 0.558	126	154
Mayang Ebos 203	38.98 ± 3.451	131	167
Radin 2	36.21 ± 2.856	126	154
Radin China 4	31.18 ± 0.266	128	157
Radin Siak 24	29.85 ± 1.791	126	154
Siam 29	28.03 ± 1.942	126	156
Reyong 20	21.17 ± 0.593	126	154

TABLE 3

A comparison of yield and days of maturity of the different varieties of rice from the Federated Malay States in their original country and at Los Baños

VARIETIES	YIELD		MATURITY PERIOD	
	Federated Malay States	Average of two plantings in the Philippines	Federated Malay States	Average of two plantings in the Philippines
	cavans	*cavans*	*months*	*months*
Seraup Kechil 146	82.87	70.99	8.0	5.5
Seraup Kechil 36	68.63	66.90	8.0	6.0
Seraup Besar 15	68.63	62.15	8.0	5.5
Radin 2	64.88	43.02	6.5	5.0
Mayang Ebos 203	—	38.51	6.0	5.5
Siam 29	68.63	38.18	6.5	5.0
Radin Siak 24	48.40	30.07	6.5	5.0
Nachin 66	57.39	28.78	6.5	5.0
Reyong 20	76.46	22.26	6.0	5.0
Radin China 4	76.46	21.49	6.0	5.0

SOIL SURVEY OF THE MAQUILING AREA[1]

D. I. AQUINO AND J. P. MAMISAO
Of the Department of Soils

WITH TWO TEXT FIGURES AND ONE MAP

Efficient farming depends upon suitable adjustments in plant-soil relationships. A detailed soil survey enables the farmer to plan a rational system of soil management. The data from a soil survey are of value in land utilization, land evaluation, soil conservation, and planning of irrigation, drainage, and experimental projects.

Reconnaissance work does not give as much information as the detailed soil survey. However, it gives sufficient data for general recommendations, and it facilitates subsequent detailed surveys of the area.

The work reported in this paper was a reconnaissance survey[2] conducted between 1927 and 1931.

In reviewing the work on soil classification in the Philippines, Mamisao (1938) states that thirty-six soil series have been reported so far. These series which have been defined by Dorsey (1903), Pendleton (1927 and 1931), Pendleton and Aquino (1932), Alicante, and others (1936 and 1937) are found in an area of 605,000 hectares, or about two per cent of the total area of the Philippines.

Points studied in the Maquiling area

In the present survey (1) the soil types, (2) some physical and chemical properties of the various soil types, (3) crops grown in the different soil types, and (4) the average rainfall and temperature prevailing in this region were considered.

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[1] This paper is based on surveys made by Magdaleno M. Cero, Fernando Bernardo, Gregorio F. Quiaoit, Cosme O. Reynes, Pedro P. Erce, Amado A. Andrada, Agustin J. Mejia, and Pedro G. Jacomina under the direction of Dr. Robert L. Pendleton formerly professor of soils and head of the Department.

Experiment Station contribution No. 1282.

[2] A detailed soil survey of the grounds of the College of Agriculture and vicinities (this combined area represents a small portion of the Maquiling area) followed the reconnaissance work. The results of this detailed survey are not included in this paper.

Certain physical and chemical properties studied were the colloid content, pH values, and nitrate-nitrogen of the surface soil and subsoil of the different soil types mapped. The analyses were conducted in the laboratory of the Department of Soils.

MATERIALS AND METHODS

The region surrounding Mount Maquiling is known as the Maquiling area. The portion covered in the survey had an area of 32,751.21 hectares. This area was divided into eight sections, which were delineated by separate parties.

The method of soil classification used by the Bureau of Chemistry and Soils of the United States Department of Agriculture was followed throughout this work with the soil type as the unit of classification.

The plane table known as a United States Geological Survey traverse board was used in the field when the delineation of the boundaries of the soil types was made.

The final draft of the soil map was made in the Department of Soils. In determining the area occupied by each soil type, the measurement was made on the map with the use of a planimeter.

Laboratory analyses. The method of Bouyoucos (1927) for determining colloids in soils was followed. The pH values of the samples were determined with the use of a potentiometer using a quinhydrone electrode paired with a saturated calomel half-cell. The nitrate-nitrogen content of the samples was determined colorimetrically.

DESCRIPTION OF THE AREA

Location and communication

The area surveyed surrounds Mount Maquiling. It lies between 14° 3′ and 14° 15′ north latitude, and between 120° 8′ and 120° 20′ longitude east of Greenwich. The northern part of the area is bounded by Laguna de Bay. A large part of the area is in the province of Laguna and the southwestern portion is in the province of Batangas. Eight municipalities were touched in the survey. Calamba, Los Baños, Bay, Calauan, San Pablo, and Alaminos in Laguna Province and Tanauan, and Santo Tomas in Batangas Province.

First class roads and railway lines connect all these towns. The lake-shore towns—Calamba, Los Baños, and Bay—have, in addition, the advantages of water communication with Manila and other places.

Many of the barrios and sitios,[3] especially those located inland near Mount Maquiling, can be reached only by poor class roads or frequently only by trails. Mount Maquiling is the National Botanic Gardens of the Philippines. A road suitable for motor vehicles has been under construction from the campus of the College of Agriculture and School of Forestry to the summit of the mountain. There is a trail that runs between Santo Tomas and the summit.

Geology

The geology of Mount Maquiling was studied by Abella y Casariego (1885). In 1910, Adams made a geologic reconnaissance survey of the southwestern part of Luzon and the Maquiling area was included.

There are evidences that Mount Maquiling was at one time an active volcano. However, there is no record of the last period of activity although the mountain still shows many remaining volcanic signs. Among these are the numerous thermal springs and solfataras on its slopes and along the shore of Laguna de Bay, especially in the town of Los Baños. Besides its principal focus, Mount Maquiling has also secondary foci: one in the hill of Pansol, another in Mayondon Point, and the third a crater-lake called Alligator Lake near Los Baños. There are other cinder cones of minor importance that can be found around the base of Mount Maquiling.

Mount Maquiling, as well as its subsidiary cinder cones, is now believed to be extinct. The effusive rocks are not found in the interior of the crater or in the upper flanks. Old vegetation now grows in the crater and on the slopes.

General composition. The upper slopes of Mount Maquiling are composed essentially of conglomerates and andesites with basalts. The lower slopes, as well as the area around the base, are covered with volcanic tuff and agglomerates. The mantle of tuff in the southwestern portion of Luzon is very wide in extent, covering almost the whole region and extending along the western side of Laguna de Bay northward to the bank of the Pasig River. Beyond the river, the deposits of volcanic tuff extend to the Central Plain of Luzon. But this tuff may be imputed to the foci situated in Central Luzon.

The deposit of tuff around Mount Maquiling is water laid. According to Abella y Casariego (1885), there are indications that the tuff is deposited at the bottom of a once shallow sea adjoining the mountain; these deposits gradually rose to form land. Adams (1910) states that according to von Drasche Laguna de Bay was once an arm of the sea similar to Manila Bay. Subsequent eruption of Taal Volcano separated this body of water from the sea; since then it has become fresh water.

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[3] Barrios and sitios are villages and districts into which a town is subdivided.

Physiography

Mount Maquiling stands towering with a group of hills around it; it is located on the boundary of the provinces of Laguna and Batangas. It has a height of 1,091 meters from sea level.

Abella y Casariego (1885) made a close study of the surface configuration of the mountain and its surrounding area. The slopes on the northern side are steeper than the slopes of the other three sides.

Towards the north, the lower slopes become submerged in Laguna de Bay. Along the shore rise three hills of volcanic importance—the hill at Manlilimbas Point where Alligator Lake is located, the hill of Pansol, and the hill at Mayondon Point. Pansol Hill is connected to the high slopes of Mount Maquiling by an undulating ridge. Between Molawin and Dampalit Creeks, a ridge runs northward dipping near Los Baños and continuing its course along the shore of Laguna de Bay towards Mayondon Point.

Towards the south, some secondary hills and the plateau of Tanauan and Alaminos characterize the configuration of the area.

Towards the east, there are a great number of secondary hills which connect Mount Maquiling to the small mountain of Imuc and Calauan. This chain of hills and mountains joins Mount Maquiling to Mount Banahao and its subordinate cone San Cristobal.

Towards the west, the slopes are rather depressed but undulating. Numerous secondary hills are found along the slopes towards San Juan River.

A large number of rivers and creeks are found in the Maquiling area. These streams have their origin near the crater or in springs along the slopes. All these streams empty into Laguna de Bay. San Juan River and Bay River are two streams which appear very conspicuous compared to the others. Both streams have their beginning on the southern slope of the mountain and curve northward, bounding the western and eastern sides of Maquiling.

San Juan River originates on the southwestern slope of the mountain and takes a course northwestward, passing between the towns of Tanauan and Santo Tomas, where it is called Tanauan River; but where it empties into Laguna de Bay near Calamba, its name is changed to San Juan. The river has numerous tributaries coming from the western slopes of Mount Maquiling. Biga River is one of the most important tributaries; it forms part of the boundary between Laguna and Batangas. In the upper course of Tanauan River, the bank walls are rocky and steep, but in the lower course near Calamba, the water spreads over the plain depositing its load of alluvial soil and debris on the low places.

Like San Juan River, Bay River takes other names: Pinquian in the upper course, Tigas in the middle course, Mabacan in the lower course, and it empties into the lake as Bay. There are tributaries that swell the river from the eastern slopes of Mount Maquiling and also tributaries from the northern slopes of the mountain of Imuc. The river has a deep, steep, rocky bed in the upper course; but in the lower course about the town of Bay, the water spreads over the plain.

The other streams that form the hydrographic system of Mount Maquiling are: Calo, Molawin, Maitim (also called Boot), Calios, Anos, Dampalit, Pansol, and many others of lesser importance.

The other rivers, not originating in Mount Maquiling but also affecting the formation of soil in the Maquiling area are: San Cristobal, Calauan, Gating-gating, Masapang, and Bancabanca.

Drainage

On the whole, the drainage of the Maquiling area is good to excess. Except that marshy portion along the shore of Laguna de Bay, which remains submerged in water during the greater part of the year, the level areas have fair drainage. A narrow strip of cultivable land along the shore becomes submerged only during the rainy season. This area is represented by the Bay series soils.

The lands on the slopes of Mount Maquiling have rather excessive drainage. Often soil erosion becomes very serious where adequate means of prevention are wanting. Truncation is not an unusual occurrence.

RESULTS

The delineation of the soil types is shown in the map. Five soil series represented by fifteen soil types were mapped.

Table 1 gives the results of the determinations for the pH values, nitrate-nitrogen, and colloid content of the surface soil and subsoil of the fifteen soil types.

Table 2 shows the soil types, the extent of occurrence of each, and the crops grown on them.

Table 3 shows the average monthly and annual rainfall and temperature in the College of Agriculture from 1918 to 1937.

DESCRIPTION OF THE SOIL TYPES

Ibaan series

The first soils of this series were mapped in 1903 by Dorsey about the town of Ibaan, Batangas. In the present survey, a large area was found to belong to this series. The following characteristics describe Ibaan series[4]:

> Profile—surface soil average depth 12 cm.; reddish brown in color; tenacious, difficult to till and cultivate; hard firmly baked clods found in plowed fields.
>
> Subsoil—average depth 30 cm. from the surface; heavier in texture than surface soil; more reddish in color, and at lower depths just above the underlying tuff, color grades into gray and brown as the underlying tuff. Soil is so characteristically shallow that in many places even shallow plowing brings to the surface broken bits of tuff. In some favorable places, however, the surface and subsoil may be as deep as 80 cm.
>
> Relief—generally level or gently rolling; broken at certain portions.
>
> Drainage—fair to good. Except when rainfall is heavy, artificial drainage is unnecessary.
>
> Origin of soil—residual from the decomposition of the underlying tuff.

Ibaan clay loam. The profile of this soil type is shown in figure 1. The surface soil ranges in depth from 5 to 20 cm., with an average of 15 cm. It is yellowish brown to medium brown in color. Broken bits of tuff are exposed in many places.

There is no well defined subsoil. In many places the surface soil rests directly on top of a hard pan of decomposing tuff. Whenever a subsoil is present, it occurs as a thin layer of about 10 cm. in thickness. Its color is light yellowish, approaching the color of the parent material.

A large portion of this soil occurs about Tanauan, Santo Tomas, and Calamba. Production was poor compared with that of the Lipa series soils. Especially with the sugar cane soils, fertilizers were usually applied to increase the yield.

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[4] The brief series descriptions are taken from Mamisao (1938).

Lipa series

The first soils belonging to this series were found around the town of Lipa. They were also described by Dorsey (1903). Lipa series has the following characteristics:

Profile—surface soil average depth 25 cm.; dark brown, rich-looking, mellow, easy to cultivate; generally fertile.

Subsoil—rather deep, even exceeds one meter from the surface; darker in color than surface; loamy in texture but becomes heavier and waxy at 75 cm.

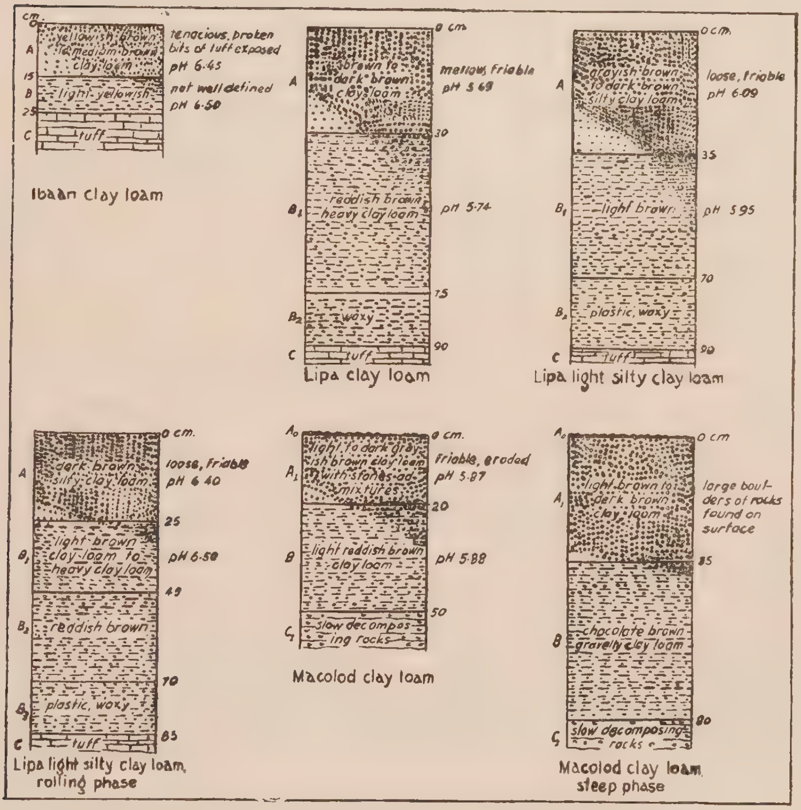
cm.
0
A
yellowish brown to medium brown clay loam
tenacious, broken bits of tuff exposed
pH 6.45
15
B
light-yellowish
not well defined
pH 6.50
25
C
tuff
Ibaan clay loam
0 cm
A
brown to dark brown clay loam
mellow, friable
pH 5.69
30
B1
reddish brown heavy clay loam
pH 5.74
75
B2
waxy
90
C
tuff
Lipa clay loam
0 cm
A
grayish brown to dark brown silty clay loam
loose, friable
pH 6.09
35
B1
light brown
pH 5.95
70
B2
plastic, waxy
90
C
tuff
Lipa light silty clay loam
0 cm.
A
dark brown silty clay loam
loose, friable
pH 6.40
25
B1
light brown clay loam to heavy clay loam
pH 6.50
45
B2
reddish brown
70
B3
plastic, waxy
85
C
tuff
Lipa light silty clay loam, rolling phase
A0
0 cm.
A1
light to dark grayish brown clay loam with stones admixtures
friable, eroded
pH 5.87
20
B
light reddish brown clay loam
pH 5.88
50
C1
slow decomposing rocks
Macolod clay loam
A0
0 cm
A1
light brown to dark brown clay loam
large boulders of rocks found on surface
35
B
chocolate brown gravelly clay loam
80
C1
slow decomposing rocks
Macolod clay loam, steep phase

Fig. 1.—Profile characteristics of the various types of residual soils.

Soil is characteristically deep and gives evidence of lasting fertility.

Relief—generally level or slightly rolling like Ibaan.

Drainage—fair to good like Ibaan; erosion very slight.

Origin—also residual from the decomposition of the underlying volcanic tuff.

Lipa clay loam. This soil is possibly older than the Lipa light silty clay loam; it is less fertile than the other soil type. The surface soil ranges in depth from 20 to 40 cm., with an average of 30 cm. The subsoil is heavier in texture than the surface soil; it is reddish brown. In some places, such as the area near Alaminos and the large area near the barrio of San Crispin, San Pablo, the subsoil is gravelly.

This soil type is found scattered in the lower slopes of Mount Maquiling. Lipa clay shows a better stand of crops than Ibaan clay loam.

Lipa light clay loam. Except for the texture of the surface soil this type of soil exhibits characteristics similar to the Lipa clay loam. Its surface soil has a depth ranging from 20 to 45 cm.

Lipa light silty clay loam. The profile of this soil type does not differ appreciably from that of the Lipa clay loam. The surface soil is grayish brown in color, loose and friable, and easy to cultivate. It is rather deep, ranging between 20 and 45 cm., with an average depth of 35 cm. It is fertile and produces a good harvest. The subsoil is light brown to dark brown; it is heavier in texture than the surface soil and becomes highly plastic when wet. It reaches a depth of 70 cm. or more.

This type is very extensive in the lowlands comprising the largest portion of the agricultural lands around Mount Maquiling.

Lipa light silty clay loam, rolling phase. As its name indicates, this type has a rolling relief; however, the grade is not sufficient to classify it under a separate series. The average depth of the surface soil is 25 cm. Like the normal phase, the soil is loose and friable, and easy to till. The subsoil is a light brown to reddish brown clay loam. This type is found close to the foot of Mount Maquiling and near river banks. The rolling character of its topography makes its drainage good. An evidence of erosion, explains why the surface soil is shallower than the normal phase of Lipa light silty clay loam.

Especially in the Alaminos region kaiñgin [5] is largely responsible for soil erosion.

Lipa loam. A very small area is occupied by this minor soil type which is very similar to Lipa clay loam except in texture of the surface soil.

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[5] Kaiñgin system is a practice in which virgin forests, especially along mountain and hill sides, are cleared of their valuable timber; and the land is grown to annual crops, such as, upland rice, corn, root crops, etc.

Macolod series

Macolod soils were first found on the slopes of Mount Macolod in Batangas province. These soils occur also on the steep slopes of Mount Maquiling and the numerous surrounding hills. The following characteristics define this series:

Profile—surface soil average depth 15 cm.; brown, tenacious with admixture of fine gravel. On the more steep slopes, black, andesitic rocks are exposed. Soil covering is thin owing to excessive soil erosion.

Topography—characteristically steep and mountainous. Erosion excessive. This explains why the soil covering is thin.

Drainage—very excessive.

Origin—derived from slow decomposition of the underlying rocks; hence, no great accumulations can take place.

Macolod clay loam. Plate 1 shows the profile characteristics of this type. Owing to the steepness of the land, there is not much chance for the soil to accumulate and mature; hence, the surface soil is shallow. Truncations where there are no grass and trees protect the surface soil from erosion. Where erosion is not serious, the surface soil accumulates to a depth of 15 to 30 cm. with an average of 20 cm. The soil is fertile, light to dark grayish brown, friable, and easy to cultivate.

Macolod soils are young. The subsoil is not distinct; often it grades with the slow decomposing parent rocks, andesites, and volcanic tuff. Where a subsoil is found, the depth reaches 50 to 60 cm. from the surface. It is usually mottled, light brown to medium brown.

Neglected kaiñgin were either covered with cogon or had already lost their fertile surface soil. Large areas along the highway between Los Baños and Calamba, are covered with ipil-ipil (*Leucaena glauca* [Linn.] Gaertn.).

Macolod clay loam, steep phase. The steep phase is found on the upper slopes of Mount Maquiling and adjoining hills. In many places, there are boulders of stones exposed on the surface. The area occupied by this soil type is covered with forest trees. A layer of litter covers the surface soil. As this matting of organic matter is spongy in character it serves to reduce the amount of run-off water in rainy days. The trees and bushes reduce the velocity of the run-off water. The roots and rootlets bind the soil mass reducing soil erosion.

The surface soil reaches a depth of 35 to 40 cm. It is light to dark brown where much humus is incorporated with the soil. Roots and rootlets are interwoven in the surface soil, while in the lower horizon, only the larger roots penetrate. The subsoil has a heavier texture with a chocolate brown color. It reaches a depth of about 80 cm. from the surface. Especially in the shallower portions the subsoil is gravelly clay loam. The substratum consists of hard rocks, which decompose very slowly.

Bay series

This series was first described by Quiaoit[6] in 1931 when he delineated the lake-shore soils. In 1937, Alicante and others defined the same series when they reported the results of the soil survey of Rizal Province.

The following characteristics define the series:

> Bay soils consist of an accumulation of sediments which have been carried into the lake by streams and washed and worked over into the present location by wave action. The soil is fertile.
>
> Topography—generally flat.
>
> Drainage—very poor because area lies below high water level of lake; usually submerged for months during the rainy season.

Bay loam. Only this type was delineated. Bay loam occurs as a narrow strip of agricultural land along the shore of Laguna de Bay. The surface soil reaches a depth of 25 cm. It is dark brown due to the presence of a large amount of humus mixed with the soil. The subsoil is dark bluish gray, reaching a depth of 60 cm. from the surface. The substratum is the same as the subsoil (figure 2).

Calumpang series

Calumpang soils are alluvial. The first soils of this type were found in the plain between Calumpang River and Batangas Bay, mapped by Dorsey in 1903. In the Maquiling area Calumpang soils are located in the wide plains along the shore of the lake. These soils have been carried and deposited by the numerous streams which empty into the lake.

The soils of the Calumpang series have the following characteristics:

> Profile—surface soil average depth 20 cm.; heavy dark-colored, stiff; bakes badly when wet; large clods formed which can be broken with difficulty.

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[6] QUIAOIT, GREGORIO F. 1931. A survey of the soil, rainfall, and temperature conditions of Mamatid-Nanhaya area. Quiaoit's work is included in this report.

Subsoil—average depth 60 cm.; waxy; black which grades into a yellowish color.

Topography—flood plains; quite level; wide terarces formed.

Drainage—very good.

Origin—alluvial soil; accumulations of fine sediment deposited by the stream in shallow water and in the flood plains.

Calumpang clay. This type is found in the plains along the shore near the towns of Calamba, Bay, and Calauan.

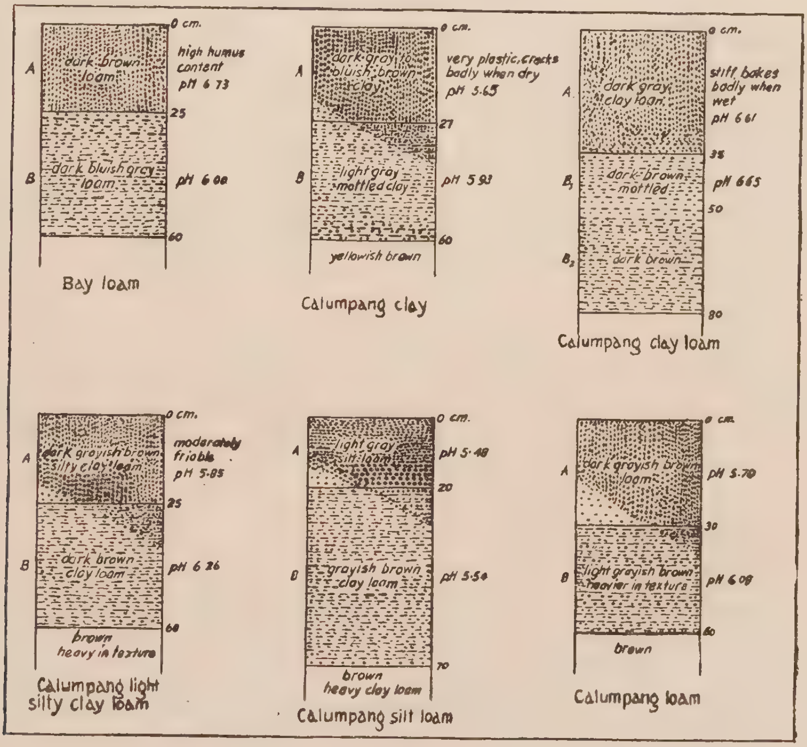
0 cm.
A
dark brown loam
high humus content
pH 6 73
25
B
dark bluish gray loam
pH 6 08
60
Bay loam
0 cm.
A
dark gray to bluish brown clay
very plastic, cracks badly when dry
pH 5.65
27
B
light gray mottled clay
pH 5 93
60
yellowish brown
Calumpang clay
0 cm.
A
dark gray clay loam
stiff bakes badly when wet
pH 6 61
35
B1
dark brown mottled
pH 6 65
50
B2
dark brown
80
Calumpang clay loam
0 cm.
A
dark grayish brown silty clay loam
moderately friable
pH 5.85
25
B
dark brown clay loam
pH 6 26
60
brown heavy in texture
Calumpang light silty clay loam
0 cm.
A
light gray silt loam
pH 5·48
20
B
grayish brown clay loam
pH 5·54
70
brown heavy clay loam
Calumpang silt loam
0 cm.
A
dark grayish brown loam
pH 5.70
30
B
light grayish brown heavier in texture
pH 6 08
60
brown
Calumpang loam

Fig. 2.—Profile characteristics of the various types of transported soils

The surface soil ranges from 25 to 40 cm. in depth, with an average of 27 cm. It is dark gray to bluish brown in color. When wet it is very plastic and sticky and cracks very badly when dry. The subsoil reaches a depth of 60 cm. from the surface. It is mottled and is of lighter color than the surface soil. It is heavy in texture. The third horizon is yellowish brown in color, occurring uniformly to as deep as 100 cm. from the surface.

Calumpang clay is rather poorly drained but it is fertile.

Calumpang heavy clay loam. This is a minor type not differing very much in profile characteristics from the Calumpang clay. Were it not for the lighter texture of the surface soil, this type might be classified with Calumpang clay.

Calumpang clay loam. Topographically Calumpang loam lies slightly higher than the preceding two soil types; hence, it is fairly well drained. It is a minor type.

The surface soil averages 35 cm. in depth. It is dark gray in color. The subsoil reaches a depth of 80 cm.; it is dark brown in color, and mottled to the depth of 50 cm.

Calumpang light silty clay loam. This type occupies a very small area near Mamatid. The surface soil ranges from 20 to 35 cm. in depth, with 25 cm. as an average. It is dark grayish grown in color and moderately friable. The subsoil reaches a depth of 60 cm. from the surface and is dark brown in color. It rests on a horizon which is brown and heavy in texture. This layer was found to occur at a depth of at least one meter. The soil is fairly well drained.

Calumpang silt loam. This type occurs in the plain near San Cristobal River. The surface soil ranges from 15 to 30 cm. with an average of 20 cm. It is light gray in color. The clods slake when exposed to showers. The soil is mellow and does not crack when dry. The subsoil is gray brown clay loam and reaches a depth of 70 cm. The underlying horizon is heavy clay loam and brown in color. The soil is fairly well drained.

Calumpang loam. The plain between San Cristobal River and San Juan River and the area on the northern bank of San Cristobal are largely occupied by this type. Owing to the recurrence of flood from time to time, the surface soil is not stable. What constitutes the first horizon is a dark grayish brown layer, about 30 cm. deep. The second horizon is lighter in color and a little heavier in texture. The soil is fairly well drained.

Non-agricultural soils

"Puting lupa". A small area of "puting lupa" (white soil) without an agricultural value was studied by Galvez (1937), who found that it contains 94.8 per cent of colloidal fractions whose diameters ranged from 0 to 0.002 mm. The white clay is used for making statues and monuments and for white-washing.

Adams (1910) explains the formation of white soil as a result of solfataric action which was once active in the place. Most solfataras are in the nature of hot muds, from which emanate boiling water and steam. The intense heat converts the surrounding rocks into white earth similar to kaolin.

Other non-agricultural soils. A large area along the shore of Laguna de Bay is occupied by marshes. Small areas of exposed tuff are found in many places in the Maquiling area. They are not shown on the map because they are very small.

SOIL TYPES AND SOIL ANALYSES

Table 1 shows the results of the determination for pH values, nitrate nitrogen, and colloid content of the soil types delineated. The figures show that there is no definite relationship between the soil types and the properties studied. Aristorenas (1937) reported that apparent and real specific gravities, maximum water-holding capacity, pore space, volume expansion, pH values, and available potash content vary considerably among samples of the same and of the different soil types in one and in different series.

Reaction. The pH value varied greatly in different soil types. Except Lipa light clay loam all of the soil types gave a slightly acidic reaction. No marked difference between the reaction of the surface soil and of the subsoil was found. Except in the Lipa light silty clay loam, the surface soil gave only slightly lower pH values than the subsoil.

Nitrate nitrogen. Nitrate nitrogen varied in the various soil types. Except in the Calumpang clay, the surface soil contained a greater amount of nitrate nitrogen than the subsoil. Calumpang clay also contained the smallest amount of nitrate nitrogen probably because it was poorly drained, the texture of the soil is rather heavy and aeration was very poor. Such condition does not permit proper nitrification. Zacate and lowland rice, grow well in this soil.

Colloid content. Table 1 shows that the heavier the texture, the higher is the percentage of colloid. Roughly, therefore, the colloid content may help in the identification of the soil types within the series. There was no marked difference between the colloid content of the surface soil and the subsoil.

SOIL TYPES AND CROPS

Table 2 gives the soil types, areas covered by the different types, and the crops grown on them. Lipa and Calumpang series soils constitute the principal agricultural lands of the Maquiling area.

Ibaan soils are not as productive as Lipa and Calumpang. The crops raised in the latter two series are also grown in the Ibaan soils.

Bay loam is a minor type.

The soils in the rolling topography are represented by Macolod series.

CLIMATE OF THE MAQUILING AREA[7]

Coronas (1920) classified the climate of the Philippines into four types, and the Maquiling area belongs to the first type. The first type has pronounced wet and dry seasons, of about equal duration. The climate of the Maquiling area, however, differs somewhat from Corona's first type. Table 3 shows that the dry spell lasts for only four months, from January to April. The average monthly rainfall hardly reaches 50 mm. From May to December, heavy rainfall is manifested; the heaviest downpour occurs in July and August.

SUMMARY

1. An area of 32,751.21 hectares around Mount Maquiling was mapped and five soil series represented by fifteen soil types were delineated.

2. Four of the soil series, Ibaan, Lipa, Macolod, and Calumpang were defined in 1903 by Dorsey in the Batangas area. The fifth series, Bay, along the shore of Laguna de Bay was mapped for the first time.

3. The five principal soil types as to extent of occurrence are (1) Lipa light silty clay loam, (2) Calumpang clay, (3) Macolod clay loam, (4) Macolod clay loam, rolling phase, and (5) Ibaan clay loam. Their combined area is about three-fourths of the total area.

4. The soils of the Maquiling area are sedentary from volcanic tuff and ash.

5. The surface soil and the subsoil of all the soil types except Lipa light clay loam were acidic in reaction. It appears that pH values can not be used as a criterion in soil classification. The surface soil was slightly more acidic than the subsoil.

6. Excepting in Calumpang clay, the amount of the nitrates in the surface soil was higher than in the subsoil. The amount of nitrate

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[7] The rainfall and temperature data collected at the College of Agriculture were obtained from the Department of Agricultural Botany. At present no other data are available in the Maquiling area.

nitrogen of the different soil types in a series and in different series varied so much that it can not also be used for soil type identification.

7. The colloid content of the various soil types in a series varied with the texture of the soil. As the texture became heavier, the percentage of colloids increased also. There was no marked difference between the colloid content of the surface soil and the subsoil.

8. The principal agricultural soil types belong to Lipa and Calumpang series. The Lipa soils were chiefly devoted to coconut, sugar cane, and rice. The minor crops were corn, legumes, vegetables, and root crops. The light-textured Calumpang soils had sugar cane and upland rice as the main crops. In the heavy-textured soils, clay and heavy clay loam, zacate and lowland rice were the most important crops. The normal phase of Macolod series were devoted to coconut and the steep phase were covered with forest. Ibaan and Bay series soils are minor agricultural soils.

9. Soil erosion was marked in Macolod clay loam and Lipa light silty clay loam, rolling phase. The kaiñgin system is the chief cause for erosion.

10. The average annual rainfall in the Maquiling area is 2,204.6 mm. The amount of rainfall in the eight wet months is thirteen times as much as that of the four dry months.

The temperature is fairly uniform throughout the year. The mean annual temperature is 27.1°C.; mean annual maximum, 30.4°C.; and mean annual minimum, 23.8°C.

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TABLE 1

pH values, nitrate-nitrogen, and colloid content of the various soil types

SOIL TYPES	pH VALUES		NO_3-N IN 100 gm. SOIL		COLLOID	
	Surface	Subsoil	Surface	Subsoil	Surface	Subsoil
			mgm.	*mgm.*	*per cent*	*per cent*
Ibaan clay loam	6.45	6.50	0.363	0.266	44.93	40.53
Lipa clay loam	5.69	5.74	—[a]	—	51.46	56.97
Lipa light clay loam	7.81	8.04	0.435	0.320	—	—
Lipa light silty clay loam ...	6.09	5.95	0.499	0.417	49.71	55.71
Lipa light silty clay loam, rolling phase	6.40	6.50	0.699	0.069	49.15	33.78
Lipa loam	5.90	5.99	0.446	0.316	27.31	36.22
Macolod clay loam	5.87	5.88	0.415	0.235	48.06	56.00
Macolod clay loam, steep phase	—	—	—	—	—	—
Bay loam	6.73	6.00	0.491	0.077	—	—
Calumpang clay	5.65	5.93	0.099	0.124	57.08	57.12
Calumpang heavy clay loam ..	—	—	—	—	—	—
Calumpang clay loam	6.61	6.65	0.305	0.072	53.54	51.44
Calumpang light silty clay loam	5.85	6.26	0.833	0.346	43.28	52.78
Calumpang silt loam	5.48	5.54	0.442	0.094	42.28	51.78
Calumpang loam	5.70	6.08	0.415	0.110	39.22	39.04

[a] No determinations were made.

TABLE 2

Soil types, their extent of occurrence, and their utilities

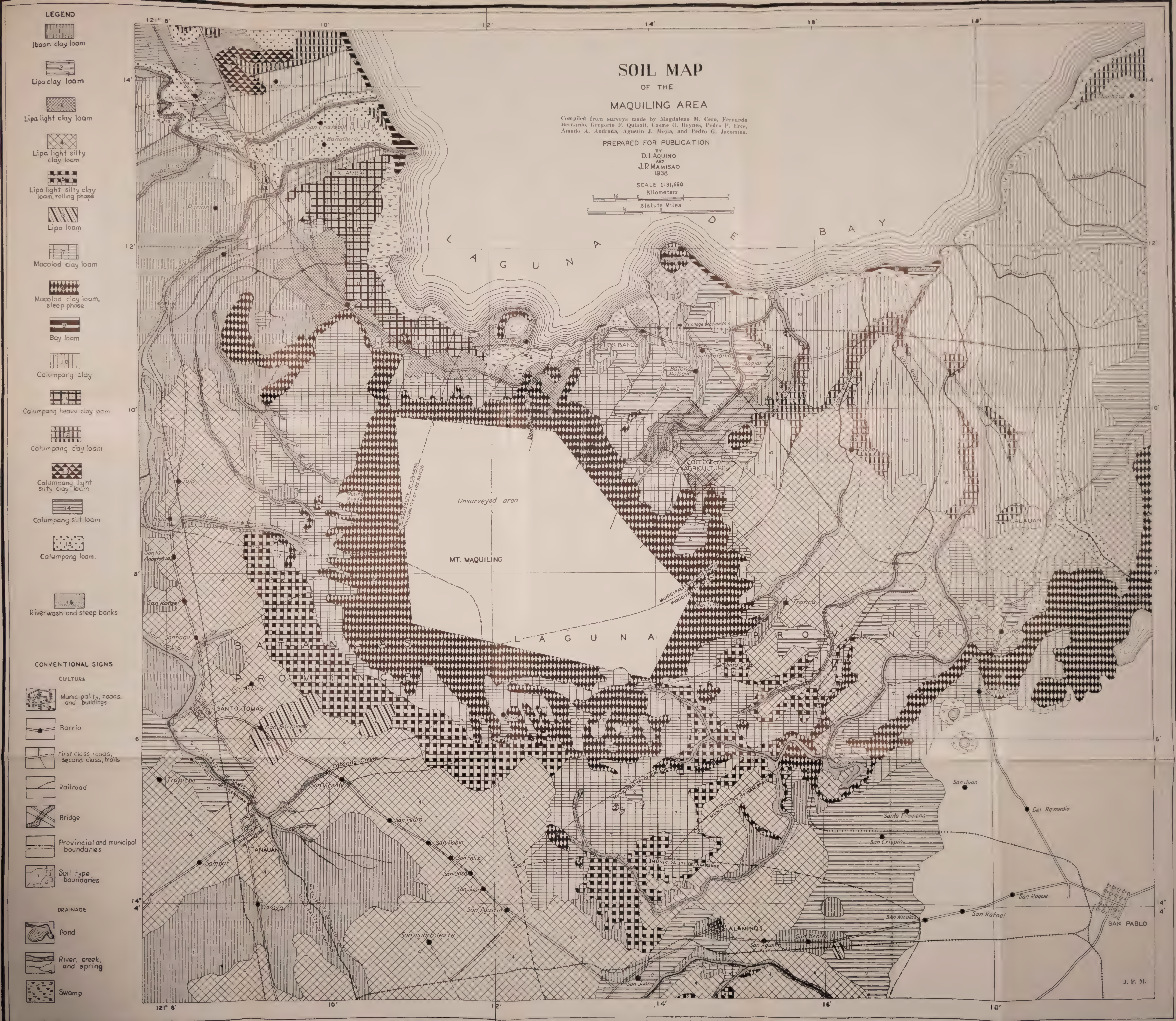
SOIL TYPES	AREA IN HECTARES	PERCENTAGE OF TOTAL AREA	UTILITIES
Ibaan clay loam	3,481.88	10.64	Sugar cane, upland rice, corn, coconut
Lipa clay loam	2,508.66	7.66	Coconut, rice, corn, sugar cane
Lipa light clay loam	477.60	1.45	Rice, corn, sugar cane, legumes, vegetables
Lipa light silty clay loam	8,458.64	25.83	Coconut, sugar cane, corn, legumes, vegetables, tobacco
Lipa light silty clay loam, rolling phase	1,475.36	4.51	Coconut, kaiñgin crops
Lipa loam	162.20	0.50	Coconut, rice, corn, sugar cane
Macolod clay loam	3,898.41	11.90	Coconut, ipil-ipil for fuel, kaiñgin crops
Macolod clay loam steep phase	3,748.22	11.44	Forest trees
Bay loam	88.11	0.27	Vegetables, corn
Calumpang clay	4,618.31	14.10	Zacate, rice
Calumpang heavy clay loam	481.61	1.47	Zacate, rice
Calumpang clay loam	662.33	2.02	Rice, corn, sugar cane
Calumpang light silty clay loam	90.11	0.28	Sugar cane
Calumpang silt loam	256.32	0.78	Sugar cane
Calumpang loam	566.71	1.73	Sugar cane, corn, banana, sincamas
Riverwash and steep banks	1,169.47	3.57	
Lake and swamp	601.26	1.83	
White soil	6.01	0.02	

TABLE 3

Average rainfall and temperature for 20 years, from 1918 to 1937, in the College of Agriculture [a]

MONTHS	RAINFALL	TEMPERATURE		
		Maximum	Minimum	Average
	mm.	*°C.*	*°C.*	*°C.*
January	58.1	27.9	22.3	25.2
February	30.6	29.1	22.3	25.7
March	25.8	31.2	23.2	27.1
April	40.1	33.0	24.0	28.5
May	161.9	33.0	24.6	28.8
June	202.0	31.8	24.5	28.1
July	340.7	30.4	24.4	27.4
August	371.7	30.4	24.3	27.4
September	265.6	30.5	24.2	27.3
October	263.4	30.1	24.4	27.2
November	287.7	28.9	23.7	26.3
December	157.0	28.1	23.1	25.6
Annual	2,204.6	30.4	23.8	27.1

[a] The data are obtained from the Department of Agricultural Botany.

SOIL MAP
OF THE
MAQUILING AREA
Compiled from surveys made by Magdaleno M. Cero, Fernando Bernardo, Gregorio F. Quiaoit, Cosme O. Reynes, Pedro P. Erce, Amado A. Andrada, Agustin J. Mejia, and Pedro G. Jacomina.
PREPARED FOR PUBLICATION
BY
D. I. AQUINO
AND
J. P. MAMISAO
1938
SCALE 1:31,680
Kilometers
1 ½ 0 1 2
Statute Miles
1 ½ 0 1
LEGEND
1 Ibaan clay loam
2 Lipa clay loam
3 Lipa light clay loam
4 Lipa light silty clay loam
5 Lipa light silty clay loam, rolling phase
6 Lipa loam
7 Macolod clay loam
8 Macolod clay loam, steep phase
9 Bay loam
10 Calumpang clay
11 Calumpang heavy clay loam
12 Calumpang clay loam
13 Calumpang light silty clay loam
14 Calumpang silt loam
15 Calumpang loam.
16 Riverwash and steep banks
CONVENTIONAL SIGNS
CULTURE
Municipality, roads, and buildings
Barrio
First class roads, second class, trails
Railroad
Bridge
Provincial and municipal boundaries
Soil type boundaries
DRAINAGE
Pond
River, creek, and spring
Swamp
121° 8'
10'
12'
14'
16'
18'
14°
14° 4'
8'
6'
LAGUNA DE BAY
LAGUNA PROVINCE
BATANGAS PROVINCE
MT. MAQUILING
Unsurveyed area
COLLEGE OF AGRICULTURE
College Station
LOS BAÑOS
CALAMBA
CALAUAN
SANTO TOMAS
TANAUAN
ALAMINOS
SAN PABLO
San Cristobal
Bañadero
Parian
Real
Tulo
Biga
Biga River
Santa Anastasia
San Rafael
Santiago
San Juan River
Pansol
Tadlac
Puting Lupa
San Antonio
Bayog
Batong Malaque
Maahas
Tranca
Santa Cruz
Imok
Lamot
Mabacan
San Bartolome
San Antonio
Cabanao Creek
San Vicente
Trapiche
Sambat
Darasa
San Pedro
San Pablo
San Felix
San Jose
San Juan
San Agustin
San Isidro Norte
San Juan
Santa Filomena
San Crispin
Del Remedio
San Roque
San Rafael
San Nicolas
San Benito
San Agustin
San Juan
MUNICIPALITY OF CALAMBA
MUNICIPALITY OF LOS BAÑOS
MUNICIPALITY OF CALAUAN
MUNICIPALITY OF SAN PABLO
MUNICIPALITY OF ALAMINOS
MUNICIPALITY OF TANAUAN
MUNICIPALITY OF STO. TOMAS
J. P. M.

BLACK SPOT OF PEANUT[1]

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Of the Department of Plant Pathology

WITH SIX TEXT FIGURES

GEOGRAPHICAL DISTRIBUTION AND IMPORTANCE

Black spot is the most prevalent and possibly the most serious disease of peanut in the Philippines. In the College of Agriculture at Los Baños, it is always present on peanut. The disease was first described briefly by Reinking in 1918. Black spot has a world wide distribution and causes various degrees of damage. According to Woodroof (1933) it is prevalent in the United States, South America, South Africa, India, Java, China, Australia, Japan, Italy, and the Philippine Islands. In the Philippines the disease causes early death of the plants owing to repeated defoliation. The actual loss caused by the disease has never been determined. Owing to heavy killing of leaves, however, the plants die many days earlier than they should. As no detailed work on the black spot of peanut has been done in the Philippines, the writers studied the disease in order to find out what measures may be used for reducing the injury brought about by the malady.

SYMPTOMS OF THE DISEASE

The first symptoms of black spot appear early in the growth of the peanut. They are minute yellowish or brownish spots on the leaves. The lesions enlarge, and as the plants grow older the spots become numerous. As the lesions attain their maximum size, they become typically black, circular spots either with or without yellow border (fig. 1). The lesions may occur on the petioles, stipules, and vines on which the spots are more or less elongate. The spots are slightly raised and are conspicuous on both surfaces of the leaves. From minute dots, the lesions may grow until they are about five millimeters in diameter. Heavy infection may cause the leaves to drop off prematurely. Repeated defoliation may result in the early death of the plants.

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[1] Read by the senior author before the Los Baños Biological Club, November 17, 1938. Experiment Station contribution No. 1283.

CAUSAL ORGANISM

Reinking (1918) attributed the black spot of peanut in the Philippines to *Septogloeum arachidis* Rac. Butler (1914, 1918) regarded the same fungus as the cause of "tikka" or black spot of peanut in India. The species, *S. arachidis,* was first described by Raciborski (1898) as the cause of leaf spot of peanut in Java. In a study of two leaf spot diseases of peanut, Woodroof (1933) concluded that black spot is caused by *Cercospora personata* (B. and C.) E. and E.

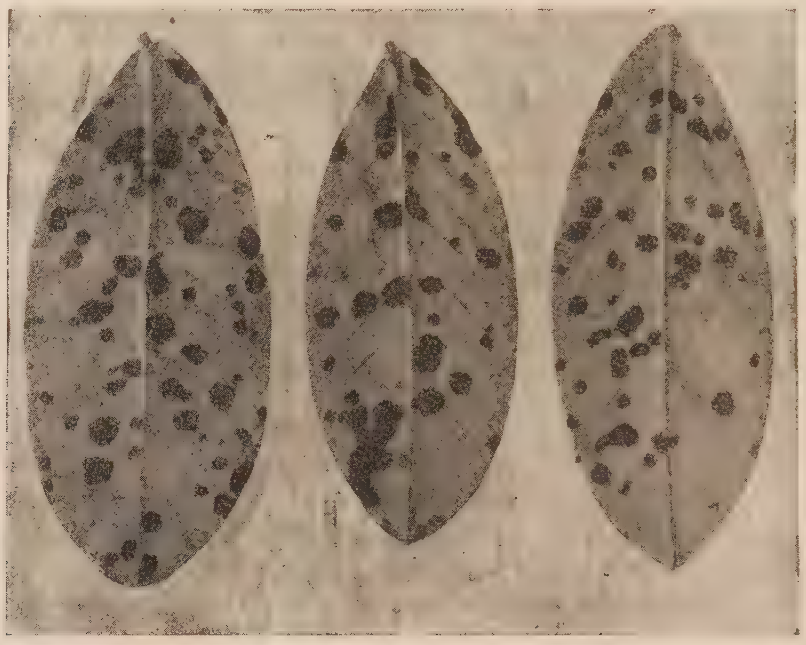

Fig. 1.—Leaves of peanut infected with black spot caused by *Cercospora personata* (B. and C.) E. and E. Photograph by Photographic Division, Department of Soils.

Failure of the fungus to grow on artificial media

Following the usual procedure and technique for isolating fungi, the tissue and the single-spore methods of isolation were employed. The culture media used included potato-dextrose agar, peanut-leaf decoction agar, corn-meal agar, malt agar, prune agar, and Czapek's agar. All attempts to isolate the fungus failed to secure any growth. In the single-spore isolation, the spores produced germ tubes. After attaining a certain length, however, the germ tubes ceased to grow any further. From the results of isolation work, the writers concluded that the fungus is not culturable. Welles (1925) reports the same experience with some species of *Cercospora*.

Morphology

Mycelium. The mycelium of the black spot fungus is found within the tissues of the host. The hyphae are branched, septate, subhyaline to slightly brownish with globular bodies contained in the filaments. The mycelium runs between the spongy mesophyll cells and palisade cells of the leaves. The haustoria that penetrate the cells (fig. 2) are lobulate. The mycelium is from 2.25 to 4.57 μ in diameter; the average is 3.41 μ.

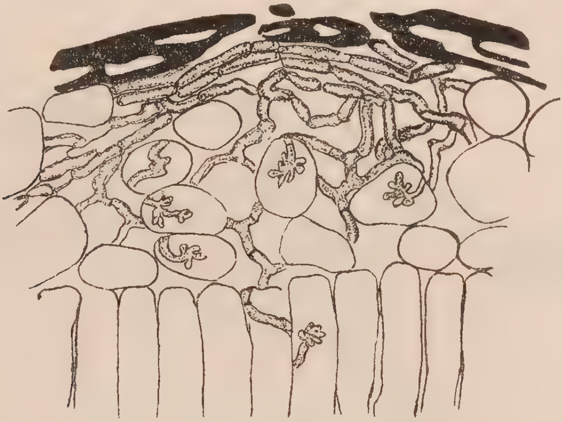

Fig. 2.—A camera lucida drawing of the cross section of a young stroma showing mycelium and haustoria of the fungus.

Conidiophores. The conidiophores are amphigenous, but they are more abundant on the lower than on the upper surface of the leaves. They form compact, short, cylindrical bundles protuding from stromatic masses of mycelium. The stromatic masses are located beneath the epidermal tissue. The conidiophores are light brown, simple, short, and irregularly bent (fig. 3). They are 28.72-80.96 × 4.02-8.9 μ; the average size is 59.84 × 6.41 μ.

Conidia. The conidia are borne singly on the conidiophores. They are olive-brown, obclavate, cylindric to subcylindric, straight or slightly curved, with rounded end cells and flattened basal cells, and 1- to 8-septate (fig. 4). The conidia are 20-55 × 6.9.5 μ; the average size is 40 × 8 μ.

Taxonomy

According to Woodroof (1933) there are two distinct leaf-spot diseases of peanut. One is caused by *Cercospora arachidicola* Hori (= *C. arachidis* P. Henn. var. *macrospora* Hoff.) and the other is caused by *Cercospora personata* (B. and C.) E. and E. (= *Cladosporium personatum* B. and C., *Septogloeum arachidis* Rac., and *C. arachidis* P. Henn.). According to Woodroof's (1933) description of the two leaf-spot diseases of peanut, the Philippine black spot differs from the leaf spot caused by *Cercospora arachidicola.* The Philippine peanut fungus is similar in many features to *Cercospora personata.* Woodroof's (1933) figures for the sizes of spores of *C. arachidicola* are 37.8-108 × 2.7-5.4 μ and for the spores of *C. personata* are 18-60 × 5.4-10.8 μ. In the Philippine *Cercospora,* the writers found that the size of the spores are 25.5-55 × 7.8-8.75 μ. These figures place the Philippine peanut fungus closer to *Cercospora personata* than to *Cercospora arachidicola.* There are slight differences in size between the spores of Woodroof's *C. personata* and the writers' fungus but the discrepancies do not warrant the segregation of the Philippine organism from *Cercospora personata* (B.

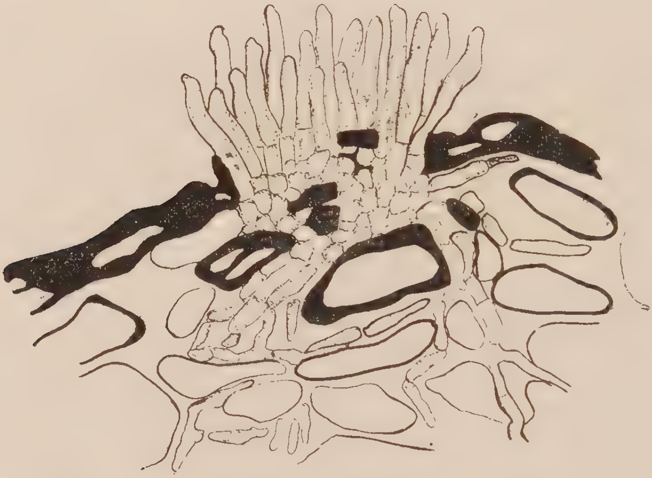

Fig. 3.—A camera lucida drawing of the cross section of a stroma showing mature conidiophores.

and C.) E. and E. For this reason the writers conclude that the black spot of peanut in the Philippines is caused by *Cercospora personata* (B. and C.) and E. and E. and not by *Septogloeum arachidis* Rac. as hitherto recorded in Philippine literature.

Inoculation experiments

As *Cercospora personata* cannot be grown in pure culture on artificial media, inoculation experiments were performed with the use of spores produced on the host plant in the field. Infected leaves bearing fresh crops of spores were carefully scraped with sterile scalpel and the conidia were suspended in sterile water in an atomizer. The spore suspension was sprayed liberally on the plants. Sixty-seven healthy plants grown in halved kerosene cans were selected for inoculation. Before inoculation, the plants were disinfected with mercuric bichloride 1 to 1000 solution. The disinfectant was thoroughly washed off with sterile water. Twenty-six plants of the same variety, age, and size were used as checks. The check plants were treated in a similar way as those inoculated except that they were sprayed with sterile water. The inoculated and the check plants were kept in the damp chamber for 24 hours. On the following day they were placed outside of the laboratory for observation. In the inoculation experiments the earliest visible symptom of the disease appeared in six to sixteen days. The incubation period varied from two to twelve days longer than that reported in Java,

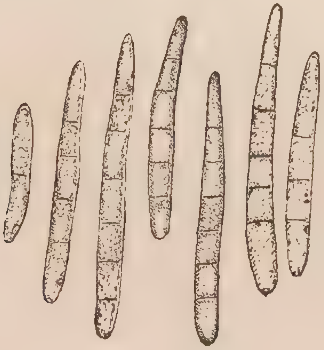

Fig. 4.—A camera lucida drawing of mature conidia of *Cercospora personata* (B. and C.) E. and E.

Ceylon, and India (Butler, 1914). The difference in period of incubation may perhaps be attributed to climatic conditions in the different regions. The control plants remained healthy and free from infection.

How the fungus lives between seasons in the field

To determine how the fungus lives between seasons in the field, observations were made in the Experiment Station of the College of Agriculture and in the Rural High School. Fields where peanuts have been grown for two or more consecutive years and fields in which peanuts have been grown for the first time were carefully observed for the prevalence and severity of black spot. The writers noted that in fields planted to peanut for several years the disease appeared earlier than in new fields. The disease caused more severe infection in old fields than on plants in fields planted the first time. The writers believe that the difference of severity of infection indicated that the parasite of the black spot was present in the field where the disease had previously occurred. An experiment performed by the writers using soil taken from fields where peanut had been grown before corroborated this assertion. Twenty-five halved kerosene cans were filled with soil infested with the fungus and planted to peanut. The peanut seeds were disinfected with 1:1000 mercuric bichloride solution before they were planted. Three seeds were planted to each can. For check the same number of cans were filled with sterilized soil and planted to three sterilized seeds of peanut.

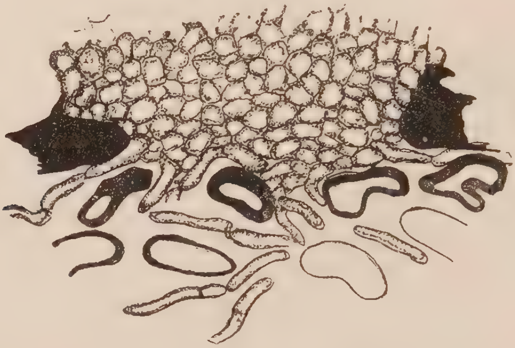

Fig. 5.—A camera lucida drawing of the cross section of a stroma from infected leaves stored for six months in the laboratory.

Both sets of cans were placed about 100 meters from any peanut field. The experiment was conducted in three replications. Observations made for six weeks showed that infection occurred in plants grown in soil taken from old peanut fields. The infection varied from 69 to 94 per cent in the three sets of planting. No infection was observed in the checks and the plants remained free from black spot throughout the course of observations. These results confirm Butler's (1914) opinion that the fungus may persist in the soil from one season to another.

Sources of infection

Refuse of diseased peanut. Experiments were conducted to determine how the fungus persists in the soil. Infected leaves and vines of peanut were collected and stored in the laboratory for about six months. At the end of six months the diseased materials were placed around the bases of abacá seedlings growing in pots in a shady place. After one week the diseased leaves and vines were sectioned, teased apart, and examined under the microscope. The examination revealed that the hyphae and stroma of *Cercospora personata* embedded in the tissues were still alive (fig. 5). In the rest of the materials examined later it was noted that the spots changed from pale brownish to dark shiny lesions. The spots were scraped off and the scrapings when examined under the microscope showed an abundance of fresh spores. This observation shows that the fungus can persist in the form of stroma (fig. 5) in the dead refuse of diseased peanut. From the stroma fresh conidia are produced. The thick masses of hyphae described by Pool and McKay (1916) as sclerotia-like structures were noted by these authors on overwintered leaves of sugar beets infected with *Cercospora beticola*. These authors state that *C. beticola* overwinters by means of sclerotia-like bodies, which produce spores early in the spring and cause initial infection. The writers conclude that *Cercospora personata* tides over adverse conditions by means of stroma on dead refuse of peanuts in the field. The diseased materials may be covered with soil. The soil covering affords protection to the fungus against adverse conditions. When favorable conditions occur, the stroma produces new conidia for infection either from old or from newly developed conidiophores (fig. 6).

Seeds of diseased plants. Butler (1914) expressed the opinion that the disease might be seed borne. In order to determine whether or not *Cercospora personata* is a seed-borne fungus twenty-five halved kerosene cans were filled with sterilized soil and planted to two or three seeds to a can. The seeds were prepared from pods taken from heavily infected plants. For checks, the same number of cans filled with sterilized soil were planted to two or three seeds which had been previously disinfected with 1:1000 mercuric bichloride solution. After being planted, the cans were placed about 500 meters away from any peanut field. Observations made for a period of six weeks showed no infection either on plants grown from seeds taken from diseased plants or on peanuts grown from sterilized seeds. This result indicates that the parasite is not carried on or within the seeds.

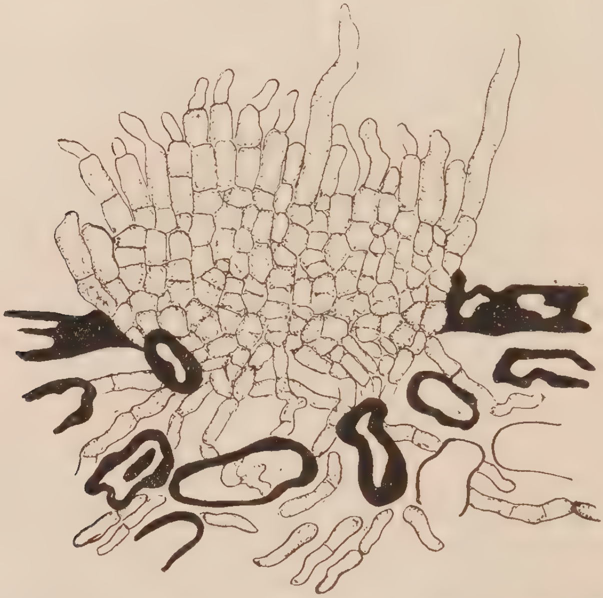

Fig. 6.—A camera lucida drawing of the cross section of an old stroma from infected leaves subjected to favorable conditions after storing in the laboratory for six months. Note the development of new conidiophores.

How the fungus is disseminated in the field

Wind. Wolf (1916), in his studies on the *Cercospora* leaf spot of peanut, found that the spores are wind-borne. Stakman, Henry, Curran, and Christopher (1923) report that spores of rusts and other fungi may be found in the air at an altitude of 11,000 feet. Ocfemia (1924) reports that spores of *Helminthosporium oryzae* Breda de Haan are carried by air, causing secondary infection during the flowering time of rice. Tests were conducted by the writers to determine if wind aids in spore dissemination of *C. personata.* The healthy peanuts growing in halved kerosene cans were exposed at distances of three to five meters away from diseased plants in the field. In addition to this test, micro-glass slides which were smeared with a thin layer of vaseline on one side were placed on supports side by side with healthy plants. Both the plants and slides were exposed to wind-borne conidia from six o'clock in the morning to six o'clock in the afternoon. Observations on infection of the plants showed that nearly all of the plants exposed for a period of six weeks became diseased. Out of 130 plants exposed, 127 plants were infected. Microscopic examination of the slides exposed with each plant showed that spores of *Cercospora personata* associated with spores of other fungi were caught. No attempts to catch spores at a distance of more than 100 meters were made. It is possible, however, for the spores of *C. personata* to be carried by wind to considerable distances. From the results the writers conclude that wind aids in the dissemination of the spores of *Cercospora personata.*

CONTROL MEASURES

Little resistance to black spot disease shown by eight varieties of peanut

Practically all of the varieties of peanuts grown in the College of Agriculture Experiment Station and elsewhere are attacked by the black spot disease. Experiments were carried out in order to determine if some varieties are superior to others in resisting infection with the disease.

The experiments were conducted in the fields of the Rural High School and in the College of Agriculture with Valencia, Lemery, Tarlac, Kinorales, Vigan Lupog, Spanish White, Santo Tomas, and Spanish Red. Fields which had been planted to peanuts infected heavily with black spot were prepared for planting. The fields were divided into plots 10 × 10 meters each. The plots were arranged according to the plan used by Hartley (1929). Each variety was subjected to the same external conditions in the fields. The plots were furrowed one meter apart, and seeds taken from healthy plants were planted in the furrows 80 centimeters apart.

Each variety of peanut was planted in three replications and the sets of planting were repeated two times during the planting season. After each planting, observations were made on infection of each variety from the appearance of the first symptoms of infection to time of harvest.

The results of the tests are summarized in tables 1a and 1b. The data presented in table 1a show that the percentage of infection of each variety was high. The difference in range of susceptibility to the disease of all varieties shown in table 1b were insignificant in all cases. Santo Tomas variety with 79.76 ± 2.20 per cent showed the least infection; and Valencia with 87.34 ± 2.02 per cent of infection, the highest. Although breeding and selection may yield peanuts with high resistance to black spot, the varieties tried exhibit practically the same degree of susceptibility to the disease.

Difficulty of controlling black spot with other measures

Judging from the results of the writers' experiments on black-spot disease of peanut, the control of the disease is a difficult matter. The disease is not seedborne. The fungus *C. personata* persists on peanut refuse in the soil and the spores are spread by wind. For these reasons seed disinfection is of no avail. Rotation of crops will be of little value because the plants can be infected with spores carried by wind from one field to another. Butler (1914) reports that spraying peanuts with Bordeaux mixture is not satisfactory because the fungus is on the under surface of the leaves and the foliage covers the ground so densely that it is difficult for the spray materials to reach the lower surface of the leaves.

SUMMARY

1. The black spot disease is the most prevalent and destructive disease of peanut in the Philippines.
2. The disease is world-wide in distribution.
3. The black spot disease is shown by circular black lesions with or without yellow borders. The spots are present on the leaves, petioles, stipules, and vines.
4. Peanut black spot is caused by *Cercospora personata* (B. and C.) E. and E. The fungus can not be grown on artificial culture media.
5. Field observations and experiments indicate that the fungus lives between seasons in the soil in the form of stroma in peanut

refuse. Old and new conidiophores from the stroma produce fresh conidia that cause primary infection.

6. The fungus is not seed-borne. Infection in the field is due to spores carried by the wind from the soil or from leaves of diseased plants.

7. None of the eight varieties of peanut tested for susceptibility and resistance to black spot showed a significant difference in reaction to the disease. All were infected with the disease in practically the same degree of severity. Attempts should be directed towards breeding and selecting strains or varieties that show increased resistance to the disease.

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TABLE 1a

The relative susceptibility to black-spot disease of eight varieties of peanut

REPLICATIONS	VARIETY USED	PLOT NO.	PLANTS IN THE PLOT	PLANTS INFECTED	INFECTION	DISEASE OBSERVATIONS
number			*number*	*number*	*per cent*	*date*
1	Kinorales	1a	198	166	83.83	February 8, 1932
	Kinorales	b	198	164	82.82	to
	Kinorales	c	196	163	83.16	March 11, 1932
2	Kinorales	2a	192	175	91.14	July 2, 1932
	Kinorales	b	199	171	85.92	to
	Kinorales	c	200	177	85.50	August 6, 1932
	Average				85.40 ± 0.8476	
1	Lemery	1a	195	171	87.69	February 8, 1932
	Lemery	b	197	174	88.32	to
	Lemery	c	198	170	85.85	March 11, 1932
2	Lemery	2a	195	173	83.72	July 2, 1932
	Lemery	b	191	149	78.01	to
	Lemery	c	193	162	83.93	August 6, 1932
	Average				84.59 ± 1.1272	
1	Sto. Tomas ...	1a	200	127	63.50	February 8, 1932
	Sto. Tomas ...	b	195	155	79.48	to
	Sto. Tomas ...	c	197	155	78.68	March 11, 1932
2	Sto. Tomas ...	2a	197	166	84.26	July 2, 1932
	Sto. Tomas ...	b	197	168	85.27	to
	Sto. Tomas ...	c	194	158	81.38	August 6, 1932
	Average				79.76 ± 2.1990	
1	Tarlac	1a	193	162	83.93	February 8, 1932
	Tarlac	b	196	162	82.65	to
	Tarlac	c	196	174	85.77	March 11, 1932
2	Tarlac	2a	197	171	87.25	July 2, 1932
	Tarlac	b	194	172	87.62	to
	Tarlac	c	194	176	85.56	August 6, 1932
	Average				85.46 ± 0.5255	

TABLE 1a (continued)

REPLICATIONS	VARIETY USED	PLOT NO.	PLANTS IN THE PLOT	PLANTS INFECTED	INFECTION	DISEASE OBSERVATIONS
number			*number*	*number*	*per cent*	*date*
1	Spanish Red ..	1a	200	160	80.00	February 8, 1932
	Spanish Red ..	b	197	170	87.31	to
	Spanish Red ..	c	198	166	83.83	March 11, 1932
2	Spanish Red ..	2a	196	165	84.18	July 2, 1932
	Spanish Red ..	b	198	169	86.36	to
	Spanish Red ..	c	192	162	84.34	August 6, 1932
	Average				84.33 ± 0.6968	
1	Valencia	1a	200	161	80.50	February 8, 1932
	Valencia	b	195	151	81.53	to
	Valencia	c	200	161	80.50	March 11, 1932
2	Valencia	2a	197	185	93.90	July 2, 1932
	Valencia	b	200	187	93.35	to
	Valencia	c	192	181	94.27	August 6, 1932
	Average				87.34 ± 2.016	
1	Vigan Lupog .	1a	195	161	82.56	February 8, 1932
	Vigan Lupog .	b	195	168	86.15	to
	Vigan Lupog .	c	198	171	86.38	March 11, 1932
2	Vigan Lupog .	2a	196	167	85.25	July 2, 1932
	Vigan Lupog .	b	198	169	85.35	to
	Vigan Lupog .	c	198	166	84.84	August 6, 1932
	Average				85.08 ± 0.405	
1	Spanish White .	1a	197	170	86.29	February 8, 1932
	Spanish White .	b	200	181	90.50	to
	Spanish White .	c	197	168	85.27	March 11, 1932
2	Spanish White .	2a	196	165	84.18	July 2, 1932
	Spanish White .	b	198	158	80.81	to
	Spanish White .	c	196	160	81.63	August 6, 1932
	Average				84.76 ± 0.954	

TABLE 1b

Differences in susceptibility to the black spot disease of the eight different varieties of peanut

VARIETIES COMPARED	DIFFERENCE	REMARKS
	per cent	
Kinorales vs. Lemery	0.19 ± 1.4103	Insignificant
Kinorales vs. Santo Tomas	5.64 ± 2.3566	Insignificant
Kinorales vs. Tarlac	—0.06 ± 0.9973	Insignificant
Kinorales vs. Spanish Red	0.07 ± 1.0972	Insignificant
Kinorales vs. Valencia	—1.94 ± 2.1868	Insignificant
Kinorales vs. Vigan Lupog	0.32 ± 0.9394	Insignificant
Kinorales vs. Spanish White	0.64 ± 1.2800	Insignificant
Lemery vs. Santo Tomas	4.83 ± 2.4711	Insignificant
Lemery vs. Tarlac	—0.87 ± 1.3436	Insignificant
Lemery vs. Spanish Red	0.26 ± 1.3251	Insignificant
Lemery vs. Valencia	—2.75 ± 2.3097	Insignificant
Lemery vs. Vigan Lupog	—0.49 ± 1.1977	Insignificant
Lemery vs. Spanish White	—0.17 ± 1.4762	Insignificant
Santo Tomas vs. Tarlac	—5.70 ± 2.2631	Insignificant
Santo Tomas vs. Spanish Red	—4.57 ± 2.3067	Insignificant
Santo Tomas vs. Valencia	—7.57 ± 2.9833	Insignificant
Santo Tomas vs. Vigan Lupog	—5.32 ± 2.2360	Insignificant
Santo Tomas vs. Spanish White	—5.00 ± 2.3970	Insignificant
Tarlac vs. Spanish Red	1.13 ± 0.8727	Insignificant
Tarlac vs. Valencia	—1.88 ± 2.0833	Insignificant
Tarlac vs. Vigan Lupog	0.38 ± 0.6635	Insignificant
Tarlac vs. Spanish White	0.70 ± 1.0891	Insignificant
Spanish Red vs. Valencia	—3.01 ± 2.5623	Insignificant
Spanish Red vs. Vigan Lupog	0.75 ± 0.8060	Insignificant
Spanish Red vs. Spanish White	—0.43 ± 1.1814	Insignificant
Valencia vs. Vigan Lupog	2.26 ± 2.0563	Insignificant
Valencia vs. Spanish White	2.58 ± 2.2303	Insignificant
Vigan Lupog vs. Spanish White	0.32 ± 1.0364	Insignificant

A COMPARATIVE STUDY OF THE ECONOMY OF EGG PRODUCTION OF BIRDS KEPT IN BATTERY LAYING CAGES AND THOSE KEPT IN OUTDOOR LAYING PENS[1]

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Much has been written during the last five years regarding the advantages of using battery cages for laying hens. Among the principal advantages that have been pointed out by those who have used the system are these: effective culling is possible; sanitation is better, for the birds are kept from contact with the ground and their droppings, and the feed and water remain uncontaminated; there is a decrease in labor in the care of the birds as well as a decrease in the feed consumption; and more birds can be accommodated in a given space. One of the drawbacks of the system, however, is the necessity of having on hand a sufficient supply of pullets for replacements if it is to be run on a profitable basis.

This study was undertaken (*a*) to compare the efficiency as egg producers of layers kept in battery laying cages and similar birds in outdoor laying pens, and (*b*) to determine the effects of the addition of cod-liver oil in the ration of outdoor layers on their egg production. The study was conducted in the poultry laboratory of the Department of Animal Husbandry from December 22, 1935, to December 21, 1936.

PLAN OF THE STUDY

A total of seventy-two Los Baños Cantonese layers, thirty-six pullets and thirty-six hens, were used in this study. These were divided into six lots, three lots with twelve pullets each and three with twelve hens each. Particular attention was made to divide uniformly the pullets according to size, and the hens according to size and previous record of egg production. The different lots were designated as follows:

Lot I—Pullets in batteries, given cod-liver oil.
Lot II—Hens in batteries, given cod-liver oil.
Lot III—Pullets in outdoor laying pens, given cod-liver oil.

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[1] Experiment Station contribution No. 1277.

Lot IV—Hens in outdoor laying pens, given cod-liver oil.
Lot V—Pullets in outdoor laying pens, without cod-liver oil.
Lot VI—Hens in outdoor laying pens, without cod-liver oil.

Each outdoor lot was penned in a laying house, 1.8 meters by 2.4 meters and provided with grass yards. The floor and dropping board were covered with a layer of lakeshore sand from Laguna de Bay. Incidentally, the sand had a generous amount of shell and grit mixed with it.

All lots were given the same basal mash ration that had been found by Olivares (1937) to be the most profitable for use in battery laying cages. This is composed of the following ingredients, parts by weight: 2 parts "Lighthouse" fish meal, 5 corn meal, 1 copra meal, and 2 rice bran with a collective nutritive ratio of 1:2.74 based on the chemical analysis of the feeds.

Lots I to IV were supplied with cod-liver oil with a specific gravity of 0.912. The cod-liver oil constituted two per cent of the ration. Powdered charcoal and common salt were also supplied in amounts of one per cent of the total mash ration. Lots V and VI received the same ration without the cod-liver oil supplement. Green feed in the form of fresh chopped mixed wild grasses obtained in the vicinity of the laboratory and grit consisting of mollusk shells were given in unlimited amounts to the battery birds, lots I and II.

Records. The initial and final weights of the birds were determined with the aid of a portable Fairbanks balance sensitive to 20 grams. The birds in the outdoor pens were trapnested, and all eggs laid were recorded. All broken and abnormal eggs laid by the battery birds were accounted for. The amount of feed consumed by the different lots was recorded. Mortality was also recorded.

RESULTS AND DISCUSSION

Egg production. It may be seen in table 1 that the egg production of the birds in the battery lots were not consistently better than those in the comparable outdoor lots. It is apparent, however, that the pullets were better layers than the hens in both battery and outdoor lots. These results are in harmony with those reported by Kennard and Chamberlain (1936) who found no difference in the egg production of caged and housed layers.

When the four outdoor pens were compared to determine the influence of cod-liver oil in the ration, it was observed that the results were also not consistent. Although the pullets that received a ration supplemented with cod-liver oil laid 4.1 per cent better than those that did not receive the supplement, the egg production of the hens was 2.0 per cent less than the comparable pen that did not receive the cod-liver oil supplement. The average egg production of both the hen and pullet lots furnished cod-liver oil when taken together was only 2.1 per cent better than the two lots not furnished cod-liver oil.

Weight of the birds. The average weights of the birds in each lot at the beginning and at the end of the experiment are given in table 2. It may be seen that all the lots gained in weight. Lot III gained more weight than the battery pullets. On the other hand, the battery hens made a gain of 0.40 kilogram per bird, or 28.8 per cent, which is much more than the comparable hens outdoors. The tendency of the lot II birds to fatten may partially explain the low average egg production obtained in this lot.

The two lots that received the ration supplemented with cod-liver oil gained more weight than the comparable lots that did not receive cod-liver oil. The addition of cod-liver oil to the ration of the outdoor layers apparently had a tendency to increase the body weight of the birds which was very strongly indicated in both the battery lots and in lot III.

Mortality. While deaths occurred in all lots, the mortality in both of the battery lots was lower than that of the comparable outdoor lots. These results are similar to those reported by Callenbach and Knandel (1935) and Kennard and Chamberlain (1936), who found that mortality of birds in battery laying cages was significantly lower than that in laying houses.

There were six birds, three pullets and three hens, that died in lots III and IV, and seven birds, two pullets and five hens, in lots V and VI. The mortality in the two lots that received cod-liver oil in the ration was 25 per cent, and in the two no-cod-liver oil lots, 29.2 per cent.

Cost of egg production. Table 4 shows that the two battery lots consumed much less feed than the two comparable outdoor lots. The battery pullets consumed 22.32 kilograms of feed each year, worth ₱1.57, and the battery hens, 20.36 kilograms worth ₱1.43. That the pullets in this case should consume more feed than the hens may be due to the higher egg production of the pullets. The two outdoor comparable lots consumed about the same amount of feed, 25.96 kilograms worth ₱1.83 in the pullet lot, and 25.70 kilograms worth ₱1.81

in the hen lot. These results corroborate those reported by Callenbach and Knandel (1935), although they apparently contradict those obtained by Kennard and Chamberlain (1936) who reported no difference in feed intake between battery and laying house layers.

It may also be seen that the average consumption of both outdoor lots fed cod-liver oil was only slightly lower than that of the outdoor lots not given cod-liver oil in the ration. There was, however, a marked difference in the cost of the feed consumed. The cost of the feed consumed by the outdoor lots not given cod-liver oil was observed to be much lower than that of the lots given cod-liver oil.

To produce a dozen eggs, lot I needed only 2.16 kilograms of feed worth 15 centavos, this being the most economical of all the lots studied. Both of the battery lots were more economical producers of eggs than the corresponding comparable outdoor lots. These results show that confinement of Los Baños Cantonese layers in battery cages invariably decreased feed consumption and produced eggs more economically than similar birds in comparable outdoor lots. These results may be explained by the fact that the battery layers, being confined and housed indoors, were less subject to adverse climatic conditions, and therefore, wasted less energy in the way of muscular activity than the outdoor lots.

It may also be noted that while there was an apparent saving of feed by the addition of 2 per cent cod-liver oil in the ration of outdoor layers, this feed, was more expensive than that consumed by the comparable pens that were not given cod-liver oil. Because of this, it cost the laying pen lots furnished cod-liver oil slightly more to produce a dozen eggs than the lots not given cod-liver oil.

On the whole, it was observed that the Los Baños Cantonese pullet lots consumed less feed per bird than the corresponding hen lots, and they were also more economical producers of eggs. This is due to the fact that the pullets are generally more active layers than the hens.

Returns from sale of eggs above cost of feed. The total income realized from the sale of eggs, as well as the cost of feed consumed and the returns from the sale of eggs above the cost of feed per layer in each lot, is also shown in table 4. It may be seen from these figures that both the pullets and hens in the battery cages gave a greater income than those in the corresponding comparable lots outdoors.

The results obtained in lots III and IV and those obtained in lots V and VI were not consistent. With the pullet and hen lots under each treatment considered as a unit, the birds in the cod-liver oil group averaged ₱1.37 each and those in the no-cod-liver oil group, ₱1.49. It may be recalled that the outdoor group fed cod-liver oil needed less feed to produce a dozen eggs than the group that did not receive this supplement and yet the returns were higher in the latter group. The addition of two per cent cod-liver oil to the ration of the cod-liver oil lots increased the cost of the ration 19.5 per cent more than an equal amount of the ration given to the no-cod-liver oil lots.

Relative efficiency of the different lots. With the three important factors, egg production, mortality, and amount of feed needed to produce a dozen eggs considered, as a basis for determining the efficiency of the different treatments studied, and the performance of lot I used as 100 per cent, it may be seen by referring to table 5 that all the pullet lots were more efficient than the hen lots in the corresponding group. Among the pullets, lot I was the most efficient, lot II was second, and lot III was the least. The same order was observed among the hens.

Taking each group as a unit, that is, the battery lots as one unit, the outdoor with cod-liver oil lots as another unit, and the outdoor without cod-liver oil as a third unit, it was observed that the battery unit with an average efficiency of 89.4 per cent was the most efficient. The outdoor unit, with cod-liver oil in the ration, was second with an average efficiency of 77.4 per cent. The least efficient, 71.3 per cent, was the outdoor unit without cod-liver oil.

Other observations. It was apparent that neither confinement in batteries nor the addition of 2 per cent cod-liver oil in the ration of outdoor layers affected the size of the eggs produced. The average weights of the eggs of all the lots studied did not show significant differences. The amount of cod-liver oil consumed depended upon the feed consumption. Each battery pullet was observed to have consumed 390 cc. of cod-liver oil worth ₱0.29 during the year, and the battery hens 360 cc. worth ₱0.27. On the other hand, each outdoor pullet used 530 cc. of cod-liver oil worth ₱0.39 and the outdoor hens, 520 cc. worth ₱0.38. The price of the cod-liver oil used was ₱2.80 a gallon, or about ₱0.74 a liter.

SUMMARY AND CONCLUSIONS

1. The egg production of the birds in the battery lots were not consistently better than those in the comparable outdoor lots. The average egg production of the battery pullets was higher than the outdoor pullets, but the reverse was true in the case of the hens.

2. The addition of cod-liver oil in the ration of the birds in the laying house likewise did not produce consistent results.

3. All birds in the different lots gained in weight. It is apparent that the addition of two per cent cod-liver oil in the ration had a tendency to increase the body weight of the birds.

4. The mortality in both battery lots was lower than the comparable outdoor lots.

5. The two battery lots studied consumed much less feed, produced more economical eggs, and gave greater returns from the sale of eggs above the cost of feed, than the comparable outdoor lots.

6. The addition of 2 per cent cod-liver oil in the ration tended to reduce feed consumption with an apparent saving of the feed, but the eggs were more expensive than those in comparable outdoor lots.

7. With egg production, mortality, and returns from the sale of eggs over the cost of feed considered as factors in determining the efficiency, the battery lots were the most efficient; the outdoor lots with cod-liver oil in the ration, second; and the outdoor lots without cod-liver oil, the least efficient.

8. It was apparent that neither confinement in batteries nor the addition of two per cent cod-liver oil in the ration of outdoor layers affected the size of the eggs produced.

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TABLE 1

Annual egg production of the different lots

LOT	PLACE	KIND	COD-LIVER OIL	EGG PRODUCTION	
				per cent	*number*
I	Battery	Pullets	Yes	33.9	124.1
II	Battery	Hens	Yes	24.4	89.3
III	Outdoor	Pullets	Yes	31.9	116.1
IV	Outdoor	Hens	Yes	26.4	96.7
V	Outdoor	Pullets	No	27.8	101.7
VI	Outdoor	Hens	No	28.4	102.9

TABLE 2

Weight of the birds in the different lots

LOT	WEIGHT		GAIN
	At the start	At the end	
	kgm.	*kgm.*	*per cent*
I	1.33	1.53	15.0
II	1.39	1.79	28.8
III	1.32	1.60	21.2
IV	1.39	1.51	8.6
V	1.32	1.44	9.1
VI	1.38	1.43	3.6

TABLE 3

Mortality of the birds in the different lots

LOT	NUMBER OF BIRDS		PERCENTAGE MORTALITY
	At the start	At the end	
I	12	11	8.4
II	12	10	16.7
III	12	9	25.0
IV	12	9	25.0
V	12	10	16.7
VI	12	7	41.7

TABLE 4

Cost of egg production of the different lots

ITEMS	LOT I	LOT II	LOT III	LOT IV	LOT V	LOT VI
Total eggs produced	1464	1049	1252	973	1168	1003
Cost of eggs produced [a]	₱43.92	₱31.47	₱37.56	₱29.19	₱35.04	₱30.09
Average feed consumed	22.32 kgm.	20.36 kgm.	25.96 kgm.	25.70 kgm.	26.27 kgm.	27.55 kgm.
Cost of feed consumed [b]	₱ 1.57	₱ 1.43	₱ 1.83	₱ 1.81	₱ 1.54	₱ 1.61
Feed to produce one dozen eggs	2.16 kgm.	2.74 kgm.	2.68 kgm.	3.19 kgm.	3.10 kgm.	3.21 kgm.
Cost of feed to produce one dozen eggs	₱ 0.15	₱ 0.19	₱ 0.19	₱ 0.22	₱ 0.18	₱ 0.19
Returns from sale of eggs over cost of feed per bird	₱ 2.15	₱ 1.25	₱ 1.69	₱ 1.09	₱ 1.51	₱ 1.48

[a] Considering the price of eggs at ₱3.00 a hundred.

[b] The cost of feed was ₱7.04 a hundred kilograms for lots I to IV and ₱5.89 for lots V and VI.

TABLE 5

Relative efficiency of the different lots [a]

PERFORMANCE COMPARED	LOT I	LOT II	LOT III	LOT IV	LOT V	LOT VI
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Egg production	100.0	72.0	94.6	77.6	82.0	82.9
Mortality	100.0	90.9	81.8	81.8	90.9	63.6
Amount of feed to produce one dozen eggs	100.0	73.2	75.9	52.3	56.5	51.4
Average	100.0	78.7	84.1	70.6	76.5	66.0

[a] Based on lot I as 100 per cent.

COLLEGE AND ALUMNI NOTES

Dr. L. B. Uichanco of the Department of Entomology arrived in the Philippines on November 19, 1938, after a four-month absence. He attended the Seventh International Entomological Congress in Berlin and the Fifth International Locust Conference in Brussels and visited research institutions in Europe, the United States, Hawaii, and Japan.

Dr. N. B. Mendiola of the Department of Agronomy and Dr. A. L. Teodoro of the Department of Agricultural Engineering left with General Paulino Santos for Mindanao on November 9 on a trip of forty-five days for the purpose of selecting sites for future settlement.

Mr. Emiliano F. Roldan '19, Instructor in Plant Pathology, obtained an average of 80 per cent in the examination for forest pathologist given by the Bureau of Civil Service on June 25, 1938, and Mr. Martin S. Celino, Assistant in Plant Pathology, obtained an average of 88.6 per cent in the examination for assistant forest pathologist, both grades being the highest in their respective examinations.

At the regular scientific meeting of the Los Baños Biological Club held on October 27, 1938, the following papers were read and discussed:

Ramie and its cultivation in Davao. By Dr. P. A. David.
The making of soft drinks. By Mr. M. R. Monsalud.
The agricultural value of the fine ejecta of Mayon Volcano. By Dr. N. Galvez, Dr. D. I. Aquino and Mr. J. P. Mamisao. The paper was read by Mr. Mamisao.

At the regular scientific meeting of the Club held on November 17, 1938, the following papers were read and discussed:

A comparative study of two bud sports of cassava and their parent varieties. By Mr. T. Mercado.
Black spot of peanut. By Mr. Emiliano F. Roldan and Mr. Arcadio F. Querijero. The paper was read by Mr. Roldan.
Studies on the effects of Mayon Volcano ash on plants: I. By Dr. R. B. Espino.

LIVE STOCK INDUSTRIES OF COCHIN CHINA, CAMBODIA, SIAM, AND MALAYA [1]

VALENTE VILLEGAS [2]
Of the Department of Animal Husbandry

WITH EIGHTEEN TEXT FIGURES

At the instance of Dr. B. M. Gonzalez, Dean of the College of Agriculture and with the approval of the Board of Regents, University of the Philippines, the writer sailed from Manila on March 15, 1938, for Saigon on the *S.S. "Barentsz"* for the purpose of making observations on the live stock industries of Cochin China, Cambodia, Siam, and Malaya. The return trip was made by way of Singapore on the *S.S. "Conte Biancamano"* which arrived in Manila on May 12, 1938. The entire trip covered a period of 59 days of which 19 days were spent in Cochin China and Cambodia, 24 days in Siam, and 9 days in Malaya.

It is hoped that the writer's observations of live stock production in other countries will serve to strenghten similar work being done in the Philippines and that certain observed practices may suggest ideas for formulating and undertaking new research projects that will lead to the solution of some of our problems in animal husbandry.

THE COUNTRIES VISITED

Cochin China. Cochin China is a French colony with an area of 22,000 square miles (56,954 sq. km.) and a population of 4,616,000 people. Rice is its principal crop. Of this country's live stock population only swine and ducks are of economic importance to the country. Pigs are exported to Singapore and ducks to Hongkong. Cochin China imports cattle and water buffaloes from Cambodia for work and for meat purposes (Anon. 1938).

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[1] Experiment Station contribution No. 1284. Read before the Los Baños Biological Club, July 28, 1938.

[2] The writer avails himself of this opportunity to express his deep appreciation and gratitude for the many courtesies extended to him by officials in the various departments of the countries visited. The help that was readily given facilitated the observations here reported.

THE PHILIPPINE AGRICULTURIST, VOL. XXVII, No. 9, FEBRUARY, 1939.

Cambodia. The Kingdom of Cambodia, a French protectorate, has a territory covering 58,000 square miles (150,211 sq. km.) most of which is in plains. The population is 3,046,000. In 1936, 679,000 hectares were under rice cultivation, 32,000 hectares under dry season corn, and 175,000 hectares under wet season corn. To cultivate the land for these crops, as well as for rubber, pepper, tobacco, cotton, kapok, legumes, peanuts, and mulberry requires a large number of work animals like cattle and water buffaloes. Elephants are also used as beasts of burden in the lumber industry (Anon., 1938).

Siam. Siam covers an area of 518,000 square kilometers and has a population of 14,464,291.[3] Its principal crop is rice, and, as in other Oriental countries, the tillage of the land is done by animals. Hence, many cattle and water buffaloes are needed to put its agricultural land into cultivation, thus affording a good market for the large animals it produces. Besides the need for work animals, the city of Bangkok with a population of 681,214 consumes about 80 head of cattle and about 5 head of water buffaloes daily. At present, there is also an existing trade with Hongkong to which some of Siam's surplus cattle and water buffaloes are exported. In former years, Singapore and Penang absorbed a large number of its export animals. In 1935-1936, as many as 6,173 cattle and 4,098 water buffaloes were exported (Anon., 1930). Swine raising is also an important industry in Siam, because pork is the principal meat diet of the people.

Malaya. Malaya has an area of 51,200 square miles (132,506 square km.) and a population, in 1931, of 4,385,346 (Grist, 1936). Of this area, 3,219,903 acres (1,303,077 hectares) are in rubber and 1,469,437 acres (594,673 hectares) are in other major crops which include rice, coconuts, pineapples and African oil palm. Another 248,486 acres (100,560.9 hectares) are in minor crops like coffee, tea, fruit trees, spices, food crops, etc. Live stock raising is only of secondary importance in its agriculture. Because of this, Malaya buys a large number of live animals for food from other countries. In 1936, the total value of large animals imported into this country was $3,148,976, Straits Settlements currency (₱3,704,677.60). In addition, poultry and poultry products, valued at $1,185,524 (₱1,394,734) were purchased during the same year (Grist, 1937).

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[3] From Siam Chronicle dated Aug. 28, 1937.

CATTLE AND WATER BUFFALOES

The raising of cattle and water buffaloes in Cambodia. It is estimated that at present there are 1,200,000 head of cattle and 600,000 head of water buffaloes in Cambodia. The principal cattle producing provinces are Takeo, Battambang (with Siemreap), Kandal, and Kompong Speu. Of water buffaloes, the provinces of Battambang (with Siemreap), Kompong Cham, Prey Veng, and Kompong Thom lead in production (Jauffret and Guinard, 1936).

Raising cattle and water buffaloes is a common practice all over Cambodia. As a rule, however, a family owns less than ten head, but a farmer has at least two work animals because, whether to the plow or the cart, animals are hitched in pairs. Besides the work stock, females are kept to produce animals for replacement or for sale. The work steers, after they have served for about five years on the plow or cart, are sold for beef purposes. The system of management is simple. The animals are turned out on the field to graze in the day time. At night, they are kept close or under the farmer's residence to be driven to the pastures again the next morning. Rice straw or corn forage is stored as supplementary feed for them in the corral.

In low places, animals are kept in elevated barns during the rainy season. Special care is given to cleanliness by bathing the animals whenever necessary. In a word, the animals particularly the work stock, are subjected to much handling and confinement, so that the true Cambodian ox or water buffalo is a docile and obedient creature. They have such a gentle disposition that only a small rope about 8 mm. in diameter is used to guide and control them while at work.

Castration is widely practiced. The benefits accruing from unsexing the bulls are so well recognized that probably less than five per cent of them are left entire. The Cambodians have their ways of performing the operation, but the government deems it wise to introduce an improved method with the use of the emasculatome.

The Cambodian cattle. The majority of Cambodian cattle belong to a definite type (fig. 1*a* and *b*). This type has a relatively light body exhibiting a long barrel set high from the ground. The head is narrow and long. The horns vary in size and in the manner that they rise from the head. Horns that are long and curved forward are common. Various solid colors, varying from cream to black are known, although the yellowish red color appears to be popular. Some are chestnut and brown in color. Judging from the animals exhibited at the Kampot and Takeo Live Stock Fairs in 1938, the Cambodian cattle, in general, are undersized. This is due possibly to lack of selection among the breeding animals. Oxen measuring 116 centimeters at the withers were common at the Kampot Fair. The best animal in the same fair was 125 centimeters high. On the other hand, it was apparent that large-sized animals may be found among the export stock. Owing to the good prices offered for the animals, the owners usually sell the large ones even if they are still suitable for work purposes.

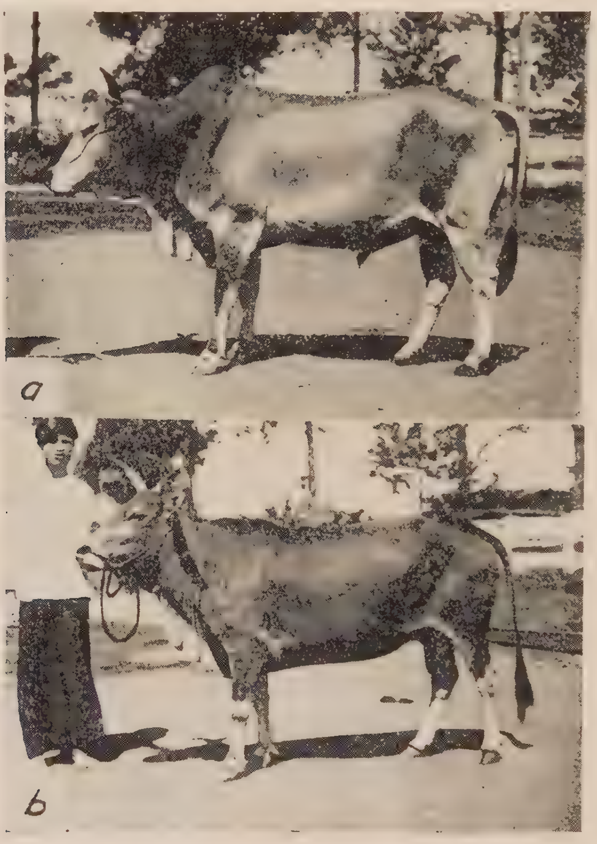

Fig. 1.—(*a*) A Cambodian bull. (*b*) A Cambodian cow. Courtesy of Dr. L. Feunteun.

The Cambodian water buffalo. Like the ox, the Cambodian water buffalo is upstanding with the head and neck carried high and the body set higher from the ground than in the case with the Philippine water buffalo (fig. 2). The horns are symmetrical, curving beautifully outward, backward, and upward. In action, it commands attention by its stylish movements. At the 1938 Kampot Live Stock Fair practically all male water buffaloes were entire, some claiming that as such they are stronger than if they are castrated. Since only a few of these animals are slaughtered for food, it is evident that in the not distant future, without any epidemic to check their multiplication, the number of water buffaloes may outnumber cattle. At present the only outlet for Cambodian water buffaloes is Cochin China where they are used in rice cultivation. Like the Cambodian cattle, the number of big-sized water buffaloes is small. One of the selected bulls at the Kampot Fair measured 128 centimeters at the withers.

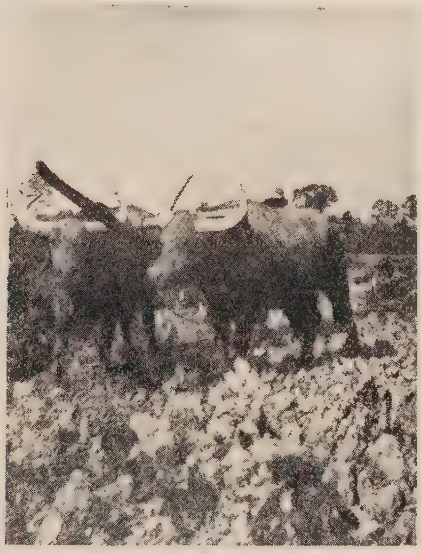

Fig. 2.—Indo-Chinese water buffaloes on the plow, Pnompenh, Cambodia.

The cattle exports of Cambodia. Cambodia has been a cattle exporting country for some time. From 1926 to 1930, cattle from Cambodia were exported to Cochin China, Singapore, and the Philippines, except in 1928 when no exportation was made to the last country. From 1931 to 1935, the exports were all for Cochin China, and in 1936 Singapore was again added to the list of cattle buyers. In 1937, it was estimated that about twice the number exported in 1936 were sent to Cochin China and about three times to Singapore. From 1930 to 1935 (Jauffret and Guinard, 1936), an average of 2,003 steers and 185 cows were exported to Cochin China yearly for work purposes, while during the same period an average of 10,363 steers a year were shipped to the same country for beef.

Export of water buffaloes. The average number of water buffaloes exported to Cochin China from 1926 to 1937 was 3,417 head yearly, the exports being exclusively for that country in 1928 and from 1931 to 1937. In 1926 and 1927, Singapore received an average of 600 head a year or 8.6 per cent of the total export. The Philippines imported in 1926, 1927, 1929, and 1930, an average of 1,288 head, which is 23.3 per cent of the total. For a period of six years, from 1930 to 1935 (Jauffret and Guinard, 1936) the annual export of the work stock shipped to Cochin China was, on an average, 3,394 males, while from 1932 to 1935, the average number of female stock sold annually to the same country was 392 head. For butchering purposes, an average of 342 males a year were shipped to the same destination in 1930, 1931, 1934, and 1935, and 111 head of female stock in 1930.

Cattle and water buffaloes in Siam. Siam has about the same number of cattle as there are water buffaloes. In the year 1936-1937[4] the number of cattle was 5,617,016 and that of water buffaloes, 5,433,424. The center of cattle and water buffalo production is in the northeastern part. There are twelve principal cattle and water buffalo producing *changvads* (provinces) in this region and the number of cattle in each *changvad* ranged from 131,764 to 500,721, the average being 262,706. With water buffaloes, the smallest number was 97,920, the largest, 372,662, and the average, 197,420 in each *changvad.* The total number of cattle in these *changvads* was 3,152,424, or 56.1 per cent of all cattle in Siam. That of water buffaloes was 2,369,038, or 43.6 per cent of the total.

For plowing purposes, the ox is largely employed on sandy and high places and the water buffalo on low, deep, muddy places. The ox as a cart animal is the chief means of transportation in the north and northeast. In conformation the cattle of Siam, except those in the south, appear to belong to the same type as those in Cambodia

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[4] Data from Department of Agriculture and Fisheries, Siam.

(fig. 3*a*). The water buffaloes, however, are different (fig. 3*b*). The body of the Siamese type is low-set while that of Cambodia is somewhat upstanding. The head and horns of the Siamese water buffaloes are not as stylish and as attractive as those of the Cambodian animal.

Although Siam is contiguous to Cambodia, there are differences in the way the animals are handled. In Siam, as many as 200 head of animals may be found in a herd belonging to a person; this is not true in Cambodia. The two countries, however, follow the same custom of selling their draft animals for meat purposes after their period of usefulness as work animals has about expired.

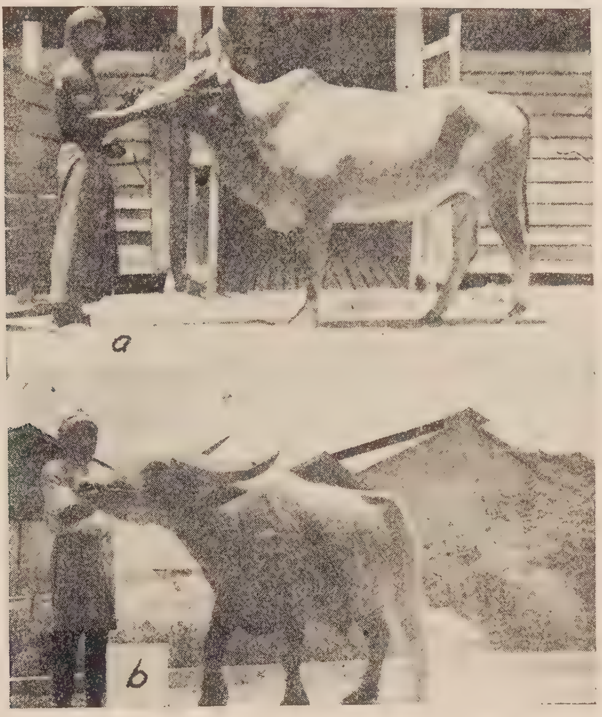

Fig. 3.—(*a*) An ox for slaughter at Bangkok Quarantine Corral. (*b*) Siamese water buffalo for export to Hongkong for slaughtering purposes.

In the south, cattle are of a different type (fig. 4). Careful selection is made among the bulls for the purpose of securing animals that are suitable for fighting purposes. Among the points emphasized are a good strong pair of horns set well apart and a well-developed chest. The horns rise upwards bending slightly to the front.

The head is short with a narrow forehead and small eyes, ears, and muzzle. The legs are short, making the animal look stocky. The base of the tail is large. The longer and finer the end of the tail or switch, the better. Black, red, and reddish gray colors are preferred. Black bulls also possess black tongues and hoofs thus making the color solid black. Good fighting bulls come from Patalung. From here they are taken to Songkla and Pattani where bull fights are held. For the purpose of bull fighting, the bulls in the south are not castrated. In the north and northeast, however, castration is generally practiced.

The Bali ox.[5] The Bali ox imported into Singapore presents definite characteristics which mark it as a distinct breed (fig. 5). It is said to have descended from *Bos Sondaicus,* and is raised pure in the island of Bali. Incidentally, mention may be made that this island is free from infectious diseases of cattle. In March, 1938, as many as 958 head[6] of Bali cattle were received in Singapore representing 78.1 per cent of the total number of cattle slaughtered in this city that month. The preference for this breed is due to the small shrinkage the animals suffer in transit and to the high dressing percentage. In its native habitat the Bali ox is used for work purposes. Only males, most of which are steers, are exported, thus preventing the multiplication of the breed in other countries as a pure breed.

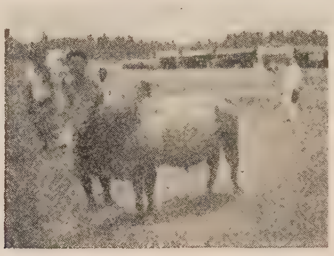

Fig. 4.—A bull of South Siam, first prize winner at Pattani Fair. Courtesy of Mr. Thuan Komkris.

The common color of the Bali ox is red, but about 10 per cent of those received in Singapore are deep brown or coffee colored. White animals exist but they are very uncommon. The eyes, muzzle, feet, and switch are black. The four legs are usually white up to just above the knees and hocks. There is a white oval area on the buttocks, and the margins of the lips are white. The breed is refined and medium in size, the males measuring 127 centimeters on an average and the females 116 centimeters at the withers. The males weigh 400 kgm. on the average and the females, 300 kgm. The head is small with medium-sized and erect ears. The face is short and wide between the eyes, which are bright and large. The poll is flat. The horns are symmetrically developed, moderate in size and pointed; they grow sideways and then upwards. The neck is short. The withers is prominent, extending a little to the back in the male. The chest is remarkably deep in some individuals, the average depth among the males being 67 centimeters and in the females, 61 centimeters. The legs are fine and the feet are somewhat flat. The hind quarters are inclined to be poorly-developed with a slight droop at the rump. Animals of this breed are timid or shy, but not vicious.

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[5] Data on origin and measurements of Bali ox from Department Van Economische Zaken, Batavia-C., Java.

[6] From Singapore Abattoir.

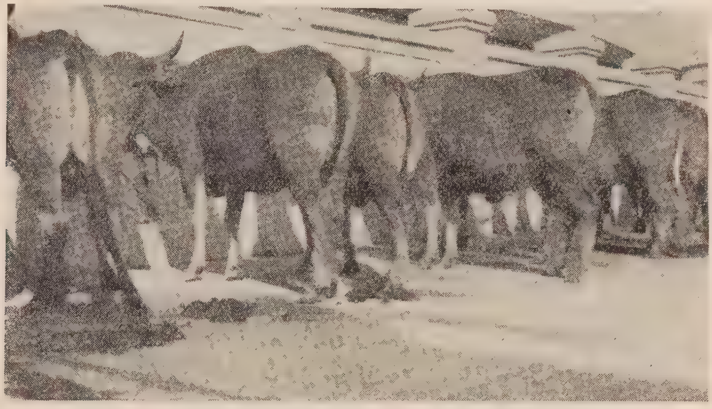

Fig. 5.—Bali cattle ready for the block, Municipal Abattoir, Singapore.

HORSE RAISING

In Cochin China, the horses are small and are used largely for pulling light vehicles (6b). Selected stallions of these horses measure 120 centimeters at the withers. A class for these stallions is provided at the race course in Phu-Tho near Saigon. In Siam, the horses were observed to be of the same type as those found in Cambodia and Cochin China. They are used mostly for transportation purposes.

DAIRYING

Dairying is an industry on which many families in Bangkok depend for a livelihood. This is true also in the other countries visited. Throughout these places, the industry is linked with the Indian population and Indian animals (fig. 7). In the majority of cases, the Indians are either the operators of the dairy or are employed as caretakers of the animals, using principally the Indian breed of cattle, water buffalo, or goat, as stock. In Bangkok and

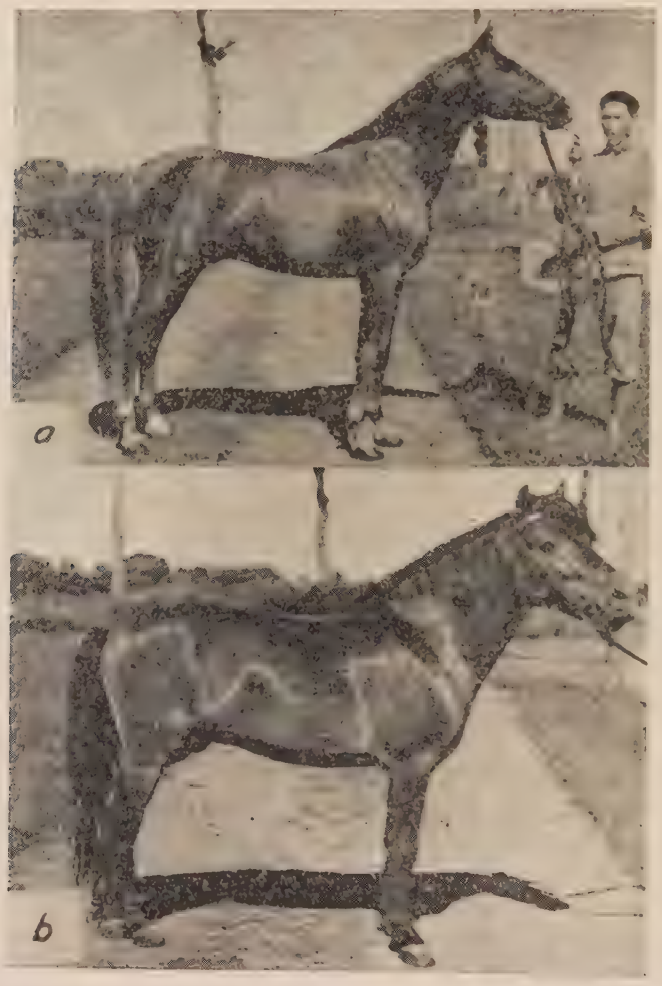

Fig. 6.—(*a*) An Arabian stallion from Algeria in stud service in Cochin China. (*b*) An Annamese studhorse in Cochin China. Courtesy of Dr. L. Feunteun.

Malaya, the number of Indian animals appears to be sufficient to allow for selection among them without recourse to further importations from India.

Dairying in Siam. The principal dairies in Bangkok are the Ban Kluey Dairy, the Kula Sovate Dairy, and the Bangkok Dairy. Besides these, there are several smaller dairies. The so-called "Bengala" or Indian cows are generally used for milking purposes. The Indian goat is also employed for the same purpose.

The Ban Kluey Dairy has 160 cattle all housed in barns with wooden floors raised one meter from the ground (fig. 8). Each barn accommodates as many as 40 animals. The animals are kept inside the barn most of the time. They are turned out into the paddocks only during good weather, between three and six o'clock in the afternoon. Bermuda and Para grass soilage is given as roughage. The concentrate mixture is made of cleaned rice, brown sugar, rice bran, and common table salt, cooked together before feeding. In another dairy, pods of the rain tree (*Samanea saman*) are also given. The milking hours are at 3:00 and 11:30 a. m. The calves are brought to the dams to stimulate milk secretion at milking time.

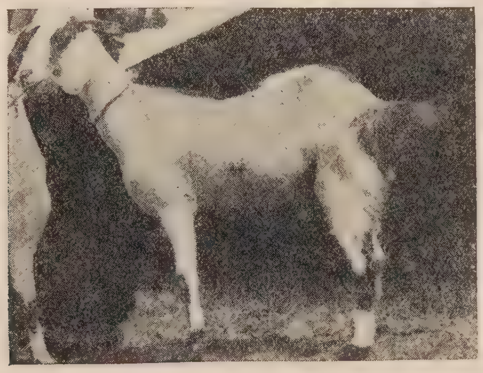

Fig. 7.—An Indian milch goat in Bangkok, Siam.

The largest dairy in Siam is located at Sub Muang, 190 kilometers east of Bangkok. It has 300 dairy animals, of which 20 Siamese, 50 Zebu and 2 "Victoria" cows were milking. The daily output is approximately 150 liters (fig. 9). The animals are given either Para or Sudan grass hay. Wide areas of these grasses are maintained nearby. The concentrate mixture consists of ½ kilogram ground palay, ½ kilogram rice bran, ½ kilogram "binlid", ½ kilogram soybean cake, 0.34 kilogram peanut cake, 0.021 kilogram common table salt, and 0.01 kilogram brown sugar. These are also cooked before feeding. To cause a large milk flow the calves are placed before the cows but not allowed to suck until after milking. Milking is done at 4:00 a. m. and 1:30 p. m. each day.

From the records of production of five Siamese and five Indian cows of similar stages of lactation, the range in the average yield of the Siamese cows was from 1.31 to 2.90 liters a head daily, the average during all lactations being 1.94 liters. With the Indian cows, the average production varied from 1.52 to 3.23 liters a head daily, the average during all lactations being 2.53 liters.

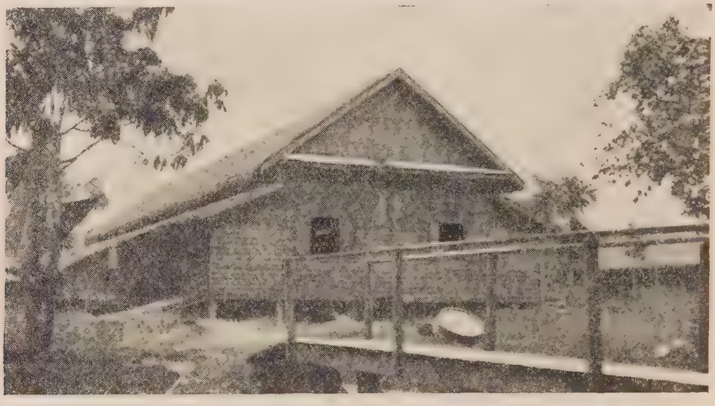

Fig. 8.—A dairy barn, Ban Kluey Dairy Farm, Bangkok, Siam. As many as 40 cows are housed in this barn. The city of Bangkok being situated on a lowland, it is necessary to keep cows in raised barns of this type.

In conjunction with the dairy, is a condensery with a homogenizer, pasteurizer, and sterilizer (fig. 10). At present, the plant takes care of all the milk produced in the dairy. The milk is standardized to a test of 3.7 per cent butterfat. Then it is placed in cans of 175 cc. capacity each. After the cover is put on the can, it is heated to a high temperature in the sterilizer, after which the milk is ready for consumption as sterilized, natural milk.

The Government Dairy Farm at Fraser's Hill (Malaya). Fraser's Hill is a holiday resort in Malaya located about 26 miles (41.8 kilometers) from Kuala Kubu Road, a railroad station. It rises 4,300 feet (1,310.6 meters) above sea level. Its average annual rainfall is 108.66 inches (276 cm.), the average temperature, 67.5°F.

(19.7°C.) and the average humidity, 91.4 per cent. From Fraser's Hill, one goes through a winding road down to the Government Dairy Farm, which is located 3,200 feet (975.4 meters) above sea level. Here, the climate is subtropical.[7] On May 2, 1938, the minimum temperature was 64°F. (17.8°C.) and the maximum, 82°F. (27.8°C.). Milk, eggs, and vegetables are produced on this farm to supply the needs of vacationists at Fraser's Hill.

The dairy farm was established in June, 1931. The Holsteins on this farm came from South Africa. At the time of this visit there were 53 head of the breed, of which 25 were cows, 27 calves, and one bull. All, except 11 animals, were born on the farm. Previous to the introduction of the Holsteins, the Indian and Jersey breeds were kept there. These have been transferred to the Central Experiment Station at Serdang to give way to the Holsteins.

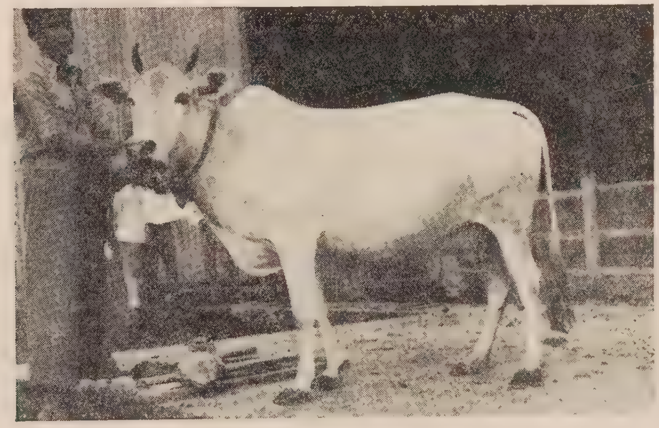

Fig. 9.—A Siamese-Indian crossbreed, the highest milking cow at dairy farm in Sub Muang, Siam.

Early in the morning before 4:00 o'clock when the cows are milked, the barn is washed. The cows are cleaned, particularly the legs, hind quarters, and udder. After being milked, the cows are fed. At 8:00 a. m. the animals are let loose in a paddock nearby until 1:00 p. m. when they are returned to the barn, fed, cleaned, and milked again at 2:30 p. m. They remain in the barn during the night.

Forty pounds (18.1 kgm.) of fresh Guinea grass is given to each cow daily. In addition, concentrates are fed in accordance with the amount of milk each produces. Dry cows get a different ration. For maintenance and a production of one gallon (3.8 liters) of milk, the concentrate mixture for each 1,000 pounds (453.6 kgm.) live weight consists of 3 pounds (1.4 kgm.) wheat bran, 3 pounds (1.4 kgm.) rice bran (parboiled), 1 pound (0.45 kgm.) maize meal, 1 pound (0.45 kgm.) Bengal gram (*Cicer arietinum*), 1 pound (0.45 kgm.) ground-nut (peanut) cake and 3 pounds (1.4 kgm.) wheaten chaff. An additional 3½ pounds (1.6 kgm.) of the mixture is given for each additional gallon (3.8 liters) of milk produced. The ration mixture for dry cows contains 3 pounds (1.4 kgm.) of wheat bran, 1 pound (0.45 kgm.) of maize meal, 1 pound (0.45 kgm.) of groundnut cake and 2 pounds (0.9 kgm.) of wheaten chaff. Besides, 4 ounces 113.4 gm.) of sterilized bone flour is given to each cow daily.

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[7] From the Malayan Meteorological Service.

Fig. 10.—Condensery at dairy farm in Sub Muang, Siam.

The calf is separated about four hours after delivery or soon after the dam has licked it. The calves are not allowed to nurse at all. In this way, separation is accomplished more readily. The colostrum is given to them in a pail. From birth up to six weeks of age, two quarts (1.9 liters) of whole milk is fed to each calf at 6:30 a. m. and the same amount at 4:30 p. m. From the sixth week until the third month of age, the same amount of milk is given morning and afternoon, but one half of the whole milk is replaced with the same quantity of skim milk. In the fourth month, only skim milk is fed at the rate of three pints (1.4 liters) in the morning and the same amount in the afternoon to which 2½ per cent of African oil palm oil has been added. At this time, from one-half to one pound (0.23 to 0.45 kgm.) of concentrates are placed before each calf once daily, also ten to fifteen pounds (4.5 to 6.8 kgm.) of Guinea grass. There is, of course, salt for the animals to lick. All young calves up to three months of age are taken outdoors for three hours each morning. The older ones, like the cows, are also sent out from 8:00 a. m. to 1:00 p. m.

At the time of the visit, the cows and calves, as well as the bull, appeared to be in good condition. They exhibited no sign of discomfort. In fact, they lay in the open, contented, under the midday summer sun (fig. 11).

The breeding records of five cows in this farm, involving 29 calvings, were taken to determine their reproductive efficiency. The average interval between calvings of each cow was found to vary from 364.8 to 442.2 days, the average interval between calvings of all cows being 390 days.

The periods of lactation and milk production of the same cows, involving 24 lactations, were studied. The lactation period of each cow ranged from an average of 267.8 to 333.0 days, the average of all lactations being 309.3 days, or about ten months. The average milk production of each cow fluctuated from 2,359.7 to 2,891.7 liters per lactation, the average for all lactations being 2,645.0 liters.

The Singapore Dairy Farm. Not far from the city of Singapore, on a site which is undulating and well-drained, is situated the Singapore Dairy Farm. This farm covers an area of over 32 hectares. Meteorological observations in Singapore show an average annual rainfall of 86.18 inches (219.9 cm.), an average temperature of 80.8°F. (28.0°C.), and an average humidity of 83.7 per cent.[8]

At the time of the visit, there were 400 Holstein cattle on the farm, 226 of which were milking. In 1934, the total output was 44,000 pounds (19,370.6 liters) of milk a month, while in February of this year, the production was 120,000 pounds (52,827 liters). Owing to the high price of fresh milk in Singapore, amounting to 52 cents Straits Settlements money, (₱0.61) a quart (0.95 liter), supreme efforts have been exerted to enable the Holstein cows to thrive well and give high yields under tropical conditions.

The system of dairy management adopted by the Singapore Dairy Farm is almost the reverse of that practiced in the native home of the animals, apparently to avoid the unfavorable effects of heat. The animals are kept loose in herds inside the barns at all times, except in the morning between 5:30 and 10:30 o'clock when they are driven into the pasture. If the weather permits, they are again placed in the pasture at night. To make the barns cool, nipa is used for roofing and the sides are left open to allow free circulation of air. Air is pumped into the barns through large galvanized iron tubes provided with many openings leading into the barn. In this way, the atmosphere in the barn is kept fresh and comfortable. Dry cows and calves are, however, kept in an unventilated barn. The floor of all the barns is covered with sawdust which is replaced once a week.

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[8] From the Malayan Meteorological Service.

At milking time, the animals are brought to a barn with sanitary concrete flooring. Milking is done three times a day, at 5:30 a. m., 10:30 a. m., and at 10:30 p. m. This is done in two shifts, a second group of cows being milked three hours later. Feeding is done one hour before each milking time. The concentrate mixture consists of 380 parts, by weight, of fine rice bran, 300 parts peanut cake, 150 parts copra meal, 50 parts brown sugar, 100 parts brewer's grains, 20 parts mineral mixture and 10 parts common table salt. The mineral mixture contains potassium iodide, 7 ounces (198.5 gms.) table salt, 100 pounds (45.4 kgm.) calcium carbonate, 100 pounds (45.4 kgm.), and bone flour, 100 pounds (45.4 kgm.). Alfalfa is given only to cows giving more than 10 pounds (4.4 liters) of milk a day. Fresh soilage in the form of napier grass and guinea grass is amply provided on the farm, napier grass being preferred. More grass than the animals can consume is supplied even during the dry season. Particular attention is given to the cultivation and fertilization of the grass cultures. Fresh manure from the barns is

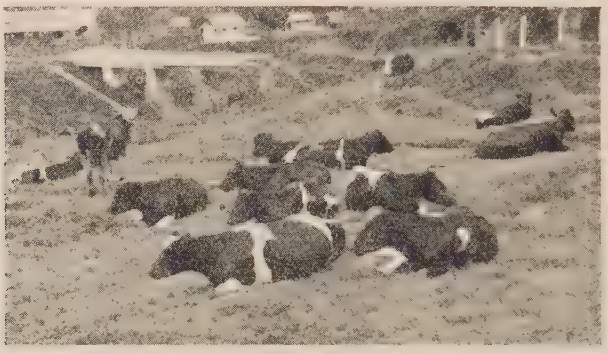

Fig. 11.—Holstein cows taking their sun bath at midday at Government Dairy Farm, Fraser's Hill, Malaya.

hauled daily and applied on these cultures. The richness and succulence of the grasses undoubtedly account in a measure for the relatively good flow of milk and well-being of the animals.

With this system of management the mortality of the animals was 17.0 per cent in 1933. The following year it rose to 22.1 per cent. It decreased steadily afterwards, being 10.2 per cent in 1935, 9.0 per cent in 1936, and only 5.2 per cent in 1937. Such significant reduction in mortality was presumably due to a combination of good feeding and management, including the provision for ventilated and air-conditioned barns.

The fact that dairy cows, like the Holsteins, undergo blood impoverishment in the tropics (Manresa and Reyes, 1934) makes one expect that similar changes would take place in the composition of their milk. By way of determining whether the system of management at the Singapore Dairy Farm is favorable or not to Holstein cows, the analysis of a sample of milk produced on this farm was obtained. The results show that the specific gravity was 1.03. The total solids amounted to 12.45 per cent, of which 8.5 per cent was non-fat solids and 3.95 per cent butter fat. Analysis of eleven other samples for butter fat gave an average percentage of 3.99, the range being from 3.65 to 4.35 per cent. According to Wing (1909), the milk of Holstein cows normally contains 11.85 per cent total solids and 3.42 per cent butter fat. It is evident from the data presented that the composition of the milk of the animals at the Singapore Dairy Farm is even slightly superior to that given by Wing.

Trying the air-conditioned barn. A new idea in dairy management is being tried out on this farm which uses air-conditioning (fig. 12). The cows are kept indoors most of the time during the warmer part of the day. The temperature in the barn is kept at about 70°F. (21.1°C.), with humidity at 60 per cent. It costs approximately $0.50, Straits Settlements money, (₱0.59) a cow daily to operate the air-conditioned barn. The results so far obtained in this venture are encouraging. During the last six months, the animals which were kept in the air-conditioned barn produced an average of 24 pounds (10.6 liters) a head a day as compared with an average yield of only 9 pounds (4.0 liters) in the ventilated barn. One Holstein cow, Milbrae Netherland Daisy (fig. 13), aged 7 years, gave 13,969 pounds (6,149.3 liters) in 371 days in the air-conditioned barn. Before this time, her yield in the ventilated barn was only 7,543 pounds (3,320.3

liters) on a lactation period of 240 days. Another cow, Milbrae Flowing Gold gave an average increase of 38.5 per cent while she was in the air-conditioned barn over her production in the ventilated barn during the same lactation, the percentage increase decreasing evidently because of advancing lactation.

The breeding efficiency of the animals was greater among the cows in the air-conditioned barn than with those in the ventilated barn. Out of twelve cows in the air-conditioned chamber, seven, or 58 per cent conceived in five months, while only three, or 25 per cent became pregnant out of the same number of animals in the ventilated barn. These figures indicate, however, that while the air-conditioned barn favored reproduction still the breeding ability of the cows in this barn can not be considered quite satisfactory. It was further observed that under both conditions, it took an average of 2.6 matings to bring about conception among those kept in the air-conditioned barn and almost the same, or an average of 2.1 times, for those in the ventilated barn.

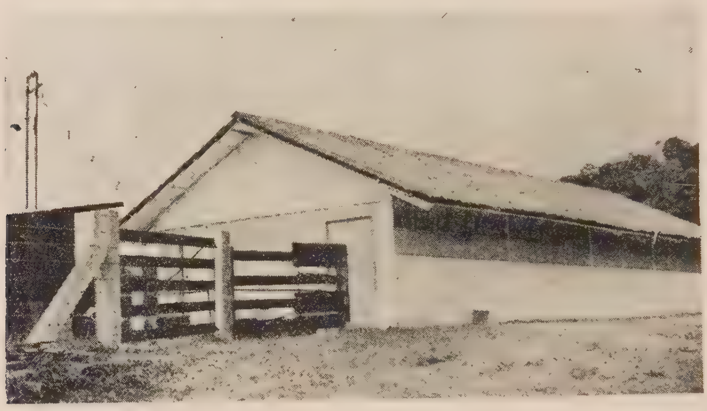

Fig. 12.—Air-conditioned barn at Singapore Dairy Farm.

Also, it has been observed that the size and milk production of the progeny produced on the farm were inferior to those of the parents, becoming worse with animals of succeeding generations. Gonzalez (1926), Fronda (1930), and Manresa (1937), as well as Davidson (1927), Hammond (1932), Du Toit and Bishop (1934), Rhoad (1936), and Yamane and Ono (1936), as cited by Manresa (1937), pointed out the same results with animals imported from temperate regions and taken to tropical countries.

SWINE RAISING

Swine raising is an important industry in Cochin China (Vittoz, 1936). In March, 1938, 4,268 pigs were shipped to Singapore from Saigon (fig. 14) while 222,231 head were consumed in Saigon and Cholon, a suburban town of Saigon, from May, 1935, to May, 1936. The swine districts of Cochin China are in the central and eastern parts. Of the provinces in these parts, those of My-Tho and Cho-lon have the largest number of breeding animals.

The native pigs are of five types, as follows: (1) the primitive Annamese pig, (2) the pig derived from the wild species, (3) the type possessing Chinese blood (fig. 15b), (4) the grade pig with short snout, and (5) the pig with a long head. From the economic standpoint, however, five other types of pigs are recognized; (1) Cochin China pig, called also the Delta or Mois pig (fig. 15a), (2) the grade Craonnais pig, (3) the Chinese-Annamese pig, (4) the Grade Yorkshire pig, and (5) the grade Berkshire pig.

Fig. 13.—A Holstein cow, Milbrae Netherland Daisy, seven years of age, producing 55 pounds (24.2 liters) of milk a day in an air-conditioned barn.

In Siam, the raising of swine is also an important industry, pork being the principal meat diet of the people. The number of swine in Siam is estimated to be 800,000. In Bangkok alone, as many as 17,965 head were slaughtered during the month of March, 1938. Out of 596 head butchered on April 12, 1938, 64 pigs or 10.7 per cent were for roasting or "lechon" purposes. Besides the number of swine produced for local consumption, in former years, south Siam raised a large number for exportation to Malaya. In 1935-1936, the total number of swine exported was 16,955 head.

Five strains of pigs are raised in Siam: (1) the Korat pig, (2) the Lampang pig, (3) the Chinese pig, (4) the Meo pig, and (5) the Singora pig. The Chinese pig with flabby jowls, abdomen and ham, and a distinctly sagging, ugly back is raised in and around Bangkok. The Meo pig which comes from Petchabun is of the bacon type, and looks like the wild pig. The mountain people of this region, called the Meo tribe, keep this pig. The Singora pig is differentiated from the rest in having a small head and ears; it is apparently the same as the Mois pig of Cochin China. The characteristic head and ears of this breed, although unsightly, have a decided advantage in reducing the proportion of waste in the dressed carcass.

The market center for pigs in Siam is Bangkok. Owing to the large population of this city, the number of pigs produced in the country is not quite sufficient to meet the demand. Bangkok gets its supply of pigs from various sources. In Bangkok itself, swine raising is an important industry. From Chiengmai, in the north, all along the railroad line down to Bangkok, pigs are raised. The collecting centers are Lampang, Petchabun, Lomsak, and Saphanhin. In the northeastern part, pigs are shipped by train from Korat, Kawnken, and Ubon, and to the west from Nakawn Prathom. Pigs that are raised in the south and were formerly exported to Malaya were gathered in Bandawn, Nakawn Sitamarat, and Singora.

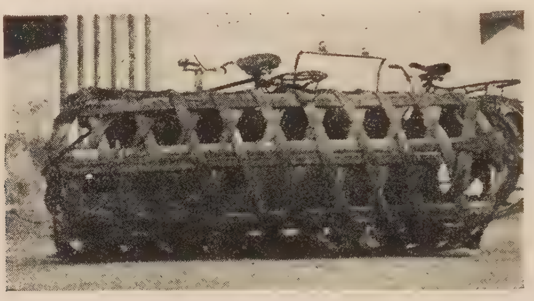

Fig. 14.—A bamboo crate with pig inside. Pigs are shipped in crates of this kind from Saigon to Singapore. By means of a bar balance the weight of the pig may be secured after deducting the weight of the crate.

In the north, pigs are driven to collecting centers in groups of 10 to 50 in a herd. The animals are tied by one of the hind legs or around the shoulder and are driven by means of a whip. Another method of driving them consists of making the herd follow a man carrying on his shoulder a can of rice bran with two or three helpers at the rear and sides of the herd to prevent the animals from dispersing. By these means, the pigs are made to travel as many as 12 kilometers a day. Traveling begins in the morning and ends at night. An improvised corral, in which the animals are kept in the meantime, is built at the stopping place which is generally made close to a body of water where the animals may drink.

In the *changvads,* the farmer usually has one or two pigs to raise. The animals are kept in pig pens or are tied by the hind leg or around the shoulder. Rice bran is the usual feed. In Bangkok, garbage is also fed. Vegetables, banana stalks, and *pukbung* (kankong, *Ipomoea reptans*) are also given. Owing to a high fee charged at the slaughterhouse, the animals are fed to the largest possible size, except in the case of roasting pigs.

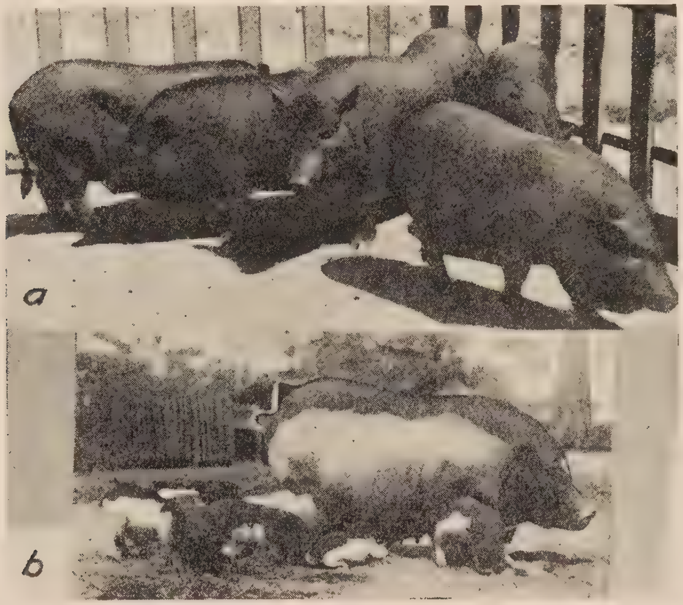

Fig. 15.—(*a*) The Cochin China or Mois breed of pigs. Note the small ears and snout. (*b*) Hainan sow with pigs, Cochin, China. The Hainan breed is considered a superior type of Chinese pigs. A large proportion of swine raised in the countries visited bear the white pattern shown in the photograph. Courtesy of Dr. L. Feunteun.

Unsexing of pigs is generally practiced. The fee for castration is 12 stangs (₱0.11) and for spaying 25 stangs (₱0.23) a head.

Females which have been spayed after having farrowed are distinguished by the presence of well-developed teats.

The Bali pig observed in Singapore possesses the conformation of the wild species. Even in sows, the fore-quarter is prominent and well developed. The head is long and strong. The bristles over the neck and on top of the shoulder are long and hard. In disposition it is wild and pugnacious. Yet, in spite of these undesirable features, the Bali pig is much appreciated in Singapore owing to the relatively higher proportion of lean it gives. In March, 1938, 6,591 head[9] or 28.5 per cent of the total number of swine slaughtered in Singapore were from Bali. The flabbiness of ham, jowl, and abdomen, characteristics of pigs from Saigon, are not observed in those from Bali. Instead, those parts are firm and hard, indicating the relative freedom of the animal from excessive fat.

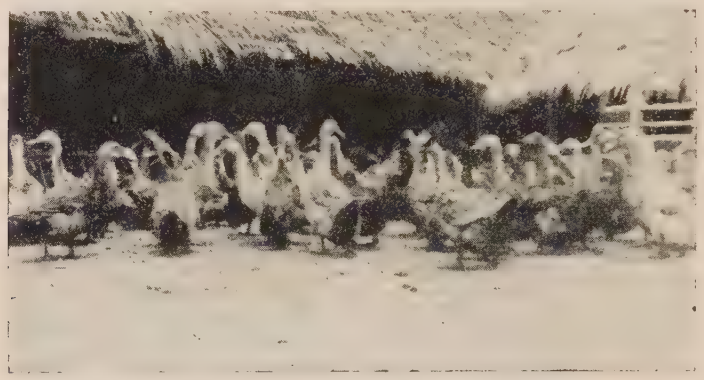

Fig. 16.—Ducks at collecting center in Bangkok.

POULTRY RAISING

Owing to the presence of a large number of large as well as small bodies of fresh water in Cochin China, Cambodia, Siam, and Malaya, duck raising is an important industry in these countries. The predominating breed of ducks raised is the *Teck* (Grist, 1936), which is small and possesses a variety of colors, similar to the ones raised in the Philippines (fig. 16). Another breed, the *Poi Chi,* is found in much smaller numbers. The birds of this breed are larger than those of the *Teck* and they have a rather uniform brown color. Ducks are raised for both eggs and meat, duck meat being one of the staple foods of the people. The *Poi Chi* ducks are raised for meat purposes only. In the markets, dressed ducks are sold side by side with dressed chickens. Likewise, roast ducks are commonly seen among the vendors of Chinese eatables. In Bangkok, ducks for the market are collected in large houses (fig. 16) where they are fed rice bran and sea clams (*Mytilus smaragdinus*) known locally as *Hoy Mang Pu.*

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[9] From Singapore Abattoir.

Chickens and geese are also raised on a large scale. There are two common breeds of chickens in Siam, namely, the *Kai Tapao* and the *Kai Oo.* Besides, there is the Meo chicken which is raised by the Meo people. The *Kai Tapao* resembles the Cantonese fowls in conformation and color, and it is claimed that it possesses meat of finer texture than that of *Kai Oo,* the game bird.

Hatcheries. In Saigon, Bangkok, Singapore, and Bukit Mertajam (Grist, 1936) in Malaya, hatcheries are established institutions. The operators of these hatcheries enjoy a lucrative business. Day-old chicks, ducklings and goslings are sold at all times and at reasonable prices. In Malaya, these are shipped by train in baskets containing about 300 birds in each basket. Approximately 15,000 to 20,000 chicks a month are shipped to Kuala Lumpur from Singapore and Bukit Mertajam. The price of each in Bangkok was: chick, 4 stangs (₱0.038); female duckling, 4-5 stangs (₱0.038-₱0.047); male duckling, 2-3 stangs (₱0.019-₱0.028); ordinary (of mixed sexes) duckling, 3-4 stangs (₱0.028-₱0.038).

The operation of one hatchery in Bangkok with a capacity of 25,000 chicks was studied. It was observed that the system of incubation is essentially the same as that used in Pateros (Fronda, 1935-1936). This particular hatchery that was studied had 21 bamboo baskets each with a capacity of 1,200 chicken or 900 duck eggs. The basket is 80 cm. deep and it has a diameter of 50 cm. Rice hulls surrounding the basket serve as insulator. The rice hulls are covered with reed mats.

The eggs are placed in bags, 100 to each bag, before they are set in the basket. The shells of the eggs are tested by tapping with the finger; only those with thick shells are considered fit for hatching. The eggs are first heated by exposing them to the sun for such length of time as would sufficiently heat them. This is judged by placing the egg against the cheek to determine the temperature. After the eggs have been arranged in the baskets, heated palay, also in bags, is placed over the different layers of eggs at the beginning of incubation. The eggs are turned over and the bags shifted from one place to another three times a day to equalize the temperature.

The eggs are candled with the use of an electric bulb on the third and fourteenth day of incubation.

After the second candling, the eggs are transferred to wooden trays with side boards 20 cm. high. The floor of these wooden trays is lined with reed mats and the sides with cotton padding to prevent breakage of eggs. During summer, a thin mosquito netting made of cotton is spread over the eggs, while in the cool season a cotton mattress ½ inch thick is used for flooring and flannel blankets are used for covering the eggs. The eggs are turned four times daily, at 5 a. m., 10:30 a. m., 3:00 p. m., and at 8:00 p. m. All eggs with dead embryos generate no heat and are removed as soon as they are detected. Based on candled eggs on the third day, the estimated percentage of hatchability is 80 per cent with duck eggs and 70 per cent with chicken eggs.

Goose eggs are also hatched in this hatchery after incubating them for 12 days under the mother. The later days of incubation of the *Poi Chi* duck eggs imported from China also take place here, the early days of incubation occurring in transit from China to Bangkok or Singapore.

Feunteun (1936) describes three ways of hatching ducks eggs in Cochin China: (1) the Annamese method, in which heated palay is used to furnish the heat at the early part of incubation at each operation; (2) the Chinese method, in which the heat is derived from an oven instead of from warmed palay; and (3) the mixed Annamese-Chinese method. In the latter method, incubation passes through three stages. The first stage lasts three days, the eggs being heated in an oven; the second stage, 12 days, with the eggs in baskets, the heat furnished by warmed palay; and the third stage, 13 days, with the eggs in trays and the heat supplied by warmed palay.

EFFORTS AT LIVE STOCK IMPROVEMENT

About 10 years ago an attempt was made in Cochin China to introduce the Ayrshire breed of cattle at a summer resort called Dalat, 1,500 meters above sea level. However, in spite of the high altitude and the salubrious climate of the place, these animals did not fare well. Now, effort is being made at improving the local stock by introducing the Red Scindi blood (fig. 17). A herd of 32 head of this breed is at present kept at the breeding station for the purpose.

The improvement of dairy animals at the Central Experiment Station at Serdang, Malaya, occupies an important position among the animal husbandry projects at this station. Since October, 1926, the station started bringing in the Montgomery or Sahiwal breed of cattle from the Government Stock Farm of India at Pusa (fig. 18). Ayrshire, Holstein, Jersey, and some more Sahiwal cattle were subsequently added to the original dairy stock. At the beginning of the work, some of the principal objects were: (1) the development of a superior strain of the Sahiwal breed, (2) the acclimatization of the Holstein cattle on the plains of Malaya and (3) the production of bulls from these two breeds to be used for cross breeding purposes, including the production of the Holstein-Sahiwal cross-breeds (Bunting and Marsh, 1934).

Observations on the Sahiwal cows showed that the average lactation was 387.5 days, the range being from 306 to 481 days. The average milk production was 3,388.8 pounds (1,491.9 liters), the lowest yield being 2,099 pounds (924.0 liters) and the highest, 4,577 pounds (2,014.9 liters). Manresa (1937) gives the best record of one of the Sahiwal cows at the Imperial Agricultural Research Institute, New Delhi, as 4,153 liters on a lactation of 304 days. The average butter fat test of the milk was 4.46 per cent. Satisfactory yields have also been obtained from two Jersey-Montgomery crossbreeds, the average production being 4,560 pounds (2,007.5 liters) on an average lactation of 285 days. The butter fat test averaged 4.3 per cent. There are at present a number of Holstein grades in the Station.

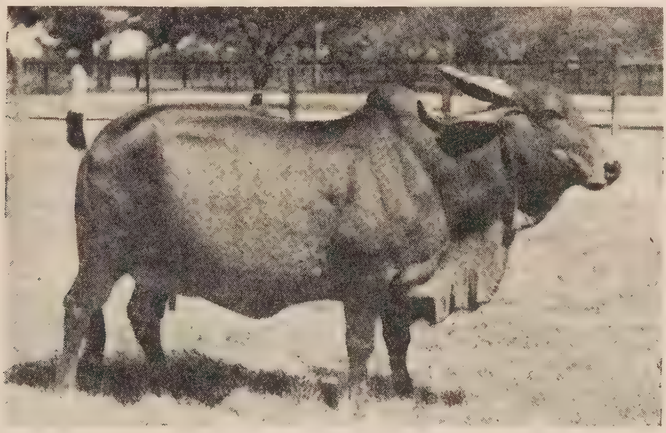

Fig. 17.—A Red Scindi cow in Cochin China. Courtesy of Service Veterinaire, Zootechnique et des Epizooties de la Cochin Chine.

Comparing these animals with those from the temperate region, Bunting and Marsh (1934) stated that "while the general health of both the locally-bred and imported Indian animals have so far proved satisfactory, that of the various European breeds has been indifferent in spite of the greatest care in housing, handling and feeding." They further mentioned that "the Indian breeds are apparently immune to Red Water Fever (Piroplasmosis) caused by the incidence of ticks, but imported cows of the European breeds are very susceptible to it; the bulls, on the other hand, once they are acclimatised, appear to resist infection." Besides the good production that the cross-breeds gave, they have also been found to be fairly immune to piroplasmosis like the Indian breeds.

At present, the policy in Malaya is to concentrate effort upon improving the Indian breeds through selection. Besides the Sahiwal breed, fifteen head of the Red Scindi breed have arrived from Karachi, India, in January of this year. The Sahiwal breed is superior to the Red Scindi in size but it is a slow breeder and possesses an ill-formed udder. Also, the dewlap and navel fold are extensive making the animal appear coarse.

Siam is passing through the early stage of an experiment, testing the value of foreign breeds of animals for improving its native stock. It has three cattle breeding stations located at the center of the cattle raising region in the northeast: namely, at Taibadan, Ta Phra, and Khonkaen. Indian cattle, including the Hissar breed, are kept in these stations. Recently. three bulls and three cows of the Shorthorn breed were imported from Australia. These are now kept in a suburban station close to the city of Bangkok.

Fig. 18.—Cows of light color possess blood of the Sahiwal breed, Central Experiment Station, Serdang, Malaya.

The improvement of the native horses of Cochin China is being accomplished with the use of the Arabian horse (fig. 6a). British horses were brought here in the past, but the Arabs are preferred because of their adaptability to local conditions. Superior native stallions, called Annamese (fig. 6b), are also kept for breeding purposes. There are now six Arabian stallions from Algeria in stud service. The colors are bay, gray, and chestnut. These stallions are of the race type, possessing a relatively light body. The legs and feet are well-developed and strong. Mention may be made of the Arab mares at the race course, also from Algeria. At the expiration of usefulness of these animals on the turf, they are retained in the country and used for breeding purposes.

The station at Serdang, Malaya raises the Large Black and Middle White pigs. Extensive use has been made of the Middle White breed for grading up the native stock. It is claimed that approximately 80 per cent of the butcher stock in Kuala Lumpur possess the Middle White blood.

In Cochin China, improvement of the native pig is accomplished with the use of the Berkshire, some of which had been imported from the Philippines.

In Siam, the smaller animals are kept at the Northern Experiment Station in Chiengmai and at the Southern Experiment Station in Haadyai. Among the swine breeds raised are the Berkshire, Tamworth, Yorkshire, Large Black, and Middle White, the latter two being English breeds little known in the Philippines. The King had also the Hampshire breed.

The chicken breeds are the Barred Plymouth Rock, Sussex, Rhode Island Red, Australorp, Orpington, and Black Leghorn. The Indian Runner and the Khaki Campbell ducks are also being tried out. At the Haadyai station, satisfactory results have been obtained with the Los Baños Cantonese and Nagoya chickens imported from the Philippines in 1934 and 1936. Hatching eggs of these breeds are in great demand in Siam.

The poultry work in Malaya is carried on at the Agricultural School since 1933. Cantonese chickens similar to the Los Baños Cantonese are used as materials for producing an improved grade of fowl using the Rhode Island Red as the source of superior blood. The original Cantonese stock was hatched from eggs purchased from a Chinese in Malaya. The school is also undertaking to form a breed of chicken using the Cantonese and the Brown Leghorn as foundation stock. Better results have so far been obtained with the Rhode Island Reds than with the other pure breeds such as the Barred Plymouth Rock, Leghorn, Australorp, Black Orpington, and Sussex. According to Grist (1936), the Rhode Island Red "has been shown to stand up to the climate and to retain its fertility and productivity for two generations, but experience of subsequent generations has yet to be obtained."

FORAGES

Like in the Philippines, it was observed that, in places where rice is an important crop, rice straw is widely used as supplementary feed for cattle and water buffaloes. Corn is also a good source of feed; in Cambodia, particularly, corn forage is cultivated on a large scale. The presence of wide areas of moist land along river banks from Cochin China through Cambodia and Siam down to Malaya affords an ideal area for the growth of a variety of grasses on which many animals subsist, especially during the dry season when pastures are short. In spite of such provisions, however, owing to the protracted and warm summer in these countries, the animals undergo privation and underfeeding during the dry season. For horses, both in Siam and Cambodia, the bermuda grass (*Cynodon dactylon*) is considered most suitable.

Of the introduced forages, guinea and napier grasses are grown as soilage crops in Siam and Malay. Para grass is raised even more extensively in Cochin China, Cambodia, and Siam, for hay and soilage purposes. In Cambodia, it thrives well on the moist, low-lying regions on the banks of the Mekong River. Sudan grass is another exotic grown on a large scale for hay purposes in Siam. Preference however, is given to para grass owing to the finer texture of the plant. Enormous quantities of hay from this grass are prepared to supply the needs of the Siamese army. The same feed is given to water buffaloes used at the Vaccine and Serum Laboratory at Pak Djong.

Trials were conducted at the Forage Station at Nong Pling, Siam. The results showed a production of para grass amounting to 35 bales of 20 kilograms each per *rai* (1,600 square meters). The cost of production per bale was 15 stangs (₱0.14) the first year, and 5 stangs (₱0.047) later. Harvesting was made twice a year. In the case of Sudan grass, the production of hay was found to be only 28 bales per *rai*. The cost of production, however, was only 10 to 12 stangs (₱0.09-₱0.11) a bale. Cutting was done four or five times a year.

In Malaya, guinea grass and napier grass are highly esteemed for feeding dairy animals. Merker grass (*Pennisetum merkeri*) is also being used satisfactorily at the Central Experiment Station at Serdang.

SLAUGHTERHOUSE PRACTICES

In Singapore, cattle and water buffaloes, as well as goats and sheep, are not stunned preparatory to bleeding as is the usual practice. Instead, the animals are tied by the legs and thrown down on the floor, and the throat and blood vessels are cut close to the bone between the lower jaw and neck, allowing the blood to flow into a hollow built in the floor.

At Pnompenh, a safe and sure pistol patented under the name "S.G.D.G." is used to stun the ox prior to bleeding. A cartridge of caliber 0.22 is loaded into this pistol. With its end directed towards the middle of the neck about two inches behind the poll, the knob at the top is pressed to release the lead which penetrates the spinal cord stunning the animal. Provided that the head is tied close enough to a railing or post, the advantages observed with this method of stunning over others lie (1) in the ease the instrument is applied to the animal, (2) in the rapidity and humane way of inflicting injury, and (3) in the certainty of stunning all animals, whether they are refractory or docile.

Cattle and carabaos are stunned in Bangkok with a modified mattock and pick. In place of the pick is a short, rounded point with which the animal is stunned. In using the tool, the handle is swung, thus giving a powerful force to the iron point as it is planted on the neck of the animal. It requires training, however, to be able to hit the right mark. Also, the head of the animal has to be tied firmly to a post to keep it from moving sideways as the tool drops on it.

At the Bangkok slaughterhouses, two classes of swine are killed, viz., pigs for roasting whole as "lechon" and large hogs for pork. The small pigs are killed in the ordinary way by sticking. After the pig has been scalded and the hair removed, both sides of the body are marked with branding irons to prevent the sale of pigs butchered outside of the government slaughterhouses. The large hogs are stunned first before they are bled. They are struck on the forehead with a club about one meter long, rounded and heavy at one end. Sometimes it requires more than one blow to render the animal unconscious and ready for bleeding.

A novel and humane way of butchering the pig is practiced in Singapore. An electric current of low amperage is discharged on the head of the animal for about 10 seconds through a pair of tongs causing it to remain paralyzed while the knife is stuck in its neck to make it bleed. The apparatus is known as the S. R. W. Electro-lethaler and is manufactured by the General Radiological and Surgical Apparatus Co., Ltd., London. With it is a step-down transformer which reduces the voltage from 230 to 70 volts. It has been observed that best results are obtained when the tongs are placed on the head of the pig either with one tong close to one eye and the other back of the opposite ear, or with both tongs just below the ears. To place both tongs back of the ears or over the eyes is ineffective.

At Pnompenh, a fee of $0.03, French Indochina currency, (₱0.019) a kilogram of dressed carcass and $0.15 (₱0.10) a head on the entrails are charged at the slaughterhouse. Besides, there is a fee of $0.10 (₱0.07) a head for the slaughter, scalding, and cleaning of pigs.

The slaughterhouse fees in Bangkok are 6 ticals (₱5.62) a head for cattle and 10 ticals (₱9.37) for water buffaloes. Swine are taxed at the rate of 5 ticals (₱4.69) for large hogs slaughtered for pork and 3 ticals (₱2.81) for small pigs for roasting.

Cattle are charged $1.00 Straits Settlements currency (₱1.17) a head for butchering in Singapore, pigs at $0.50 (₱0.59), and sheep and goats at $0.35 (₱0.41).

SUMMARY

The important results gathered in this observation trip may be summarized as follows:

1. There is a wealth of exportable cattle and water buffaloes in Cambodia and Siam. These animals are docile as a result of close handling, and because they are usually utilized as work animals before they are sold.

2. All over Cambodia, the raising of cattle and water buffaloes by the farmers is a common practice. As a rule, however, a family owns less than ten head, but the farmer has at least two work animals.

3. Cambodian oxen and Cambodian water buffaloes in general are under-sized owing to lack of selection among the breeding animals.

4. Because pork is generally preferred in Cambodia and Siam, only a relatively small number of cattle and carabaos are consumed locally as beef, leaving a big surplus for export.

5. The cattle of Siam appear to be of the same type as those of Cambodia, but the water buffaloes are low set, as contrasted with the up-standing water buffaloes of Cambodia.

6. Careful selection is made among bulls in South Siam for the purpose of securing animals that are suitable for fighting purposes, emphasizing a good pair of strong horns set well apart and a well developed chest.

7. The Bali ox is preferred as butcher stock in Singapore owing to the small shrinkage the animals suffer in transit from Bali and to its high dressing percentage.

8. In all the countries visited, dairying is an industry on which many families depend for their livelihood. Throughout these places, the industry is linked with the Indian population and Indian animals.

9. Cochin China, Cambodia, and Malaya are now using the Indian breeds of dairy cattle for milking as well as for improving the local stock by grading. Except possibly at Fraser's Hill (Malaya), they have experienced failure in maintaining dairy cattle from temperate countries.

10. The Sahiwal breed of India has been tried in Malaya for several years. The Red Scindi breed is at present under observation in Cochin China, Cambodia, and Malaya. Siam has the Hissar and the so-called "Bengala" breeds.

11. At the Singapore Dairy Farm, the air-conditioned barn is being tried to render conditions most favorable for the health and well-being of the Holstein cows. While it is rather early to draw conclusions, it is already apparent that much better yields have been obtained.

12. Swine raising is an important industry in the countries visited, particularly in Cochin China from which large shipments of pigs are exported to Singapore.

13. In Cochin China, only swine and duck raising are the animal industries that are of economic value to the country. The country imports cattle and water buffaloes from Cambodia.

14. The raising of ducks for meat in the countries visited is as important as the production of eggs from these birds. Goose meat is also held in high esteem, more so than that of ducks.

15. Hatcheries are established institutions in Saigon, Bangkok, and Singapore.

16. Siam is at the early stage of an experiment using breeds of cattle, swine, and poultry from temperate countries to improve the native stock.

17. The introduction into Siam of Los Baños Cantonese and Nagoya fowls from the Philippines has been very successful. At present eggs of these breeds are in great demand in that country.

18. The School of Agriculture at Serdang, Malaya, has started a project of establishing a breed of chickens from Brown Leghorn and Cantonese foundation stocks.

19. Arabian horses, because of their adaptability to conditions in Cochin China, are used in the improvement of the native horses in that country.

20. Siam is producing staple hay from para and sudan grasses. Para grass is also raised for soilage in paddy lands in Cambodia.

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A SEARCH FOR HIDDEN AND TRAUMATIC BUD VARIATIONS IN SWEET POTATO[1]

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WITH EIGHT TEXT FIGURES

INTRODUCTION

In a paper read on March 23, 1933, before the Society for the Advancement of Research the author proposed a new method of plant improvement based on *artificial* and *hidden variations*, to supplement those already in use (Mendiola, 1933).

The ordinary methods of improvement are based on *natural* and *exposed variations* or variations already in existence and visible. These variations consist of natural systematic groups, seminal mutations, natural hybrids, bud mutations unintentionally propagated or already severed from the mother plants, and variations produced by artificial crossing and by seed propagation with or without inbreeding.

The method proposed is based on hidden and artificial variations. By hidden variations are meant those which have already been initiated in the plant and are capable of manifestation if induced vegetatively but are lying dormant. The artificial variations referred to are those initiated by injury and hence they may be called traumatic variations.

The new method consists of propagating plants vegetatively in such a way as to induce maximum vegetative development and to inflict as much injury to the parent plant and propagation units as successful propagation will allow. The injury is expected to initiate new variations whenever the plants are in condition to respond to this stimulus. Propagation is expected to replace latent or newly initiated variations and place them in condition for artificial selection.

The method of vegetative propagation proposed by the author was outlined as follows:

1. Vegetative propagation of plants not usually multiplied in this way. Under this group fall such plants as rice, cotton, corn, different food legumes.

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[1] Part of this paper was read before the Los Baños Biological Club on January 28, 1937.

Experiment Station contribution No. 1285.

2. Vegetative propagation of plants usually grown by seed but which may be multiplied vegetatively. The methods used will involve parts not heretofore used for this purpose.

3. Vegetative propagation of plants, now ordinarily propagated asexually, by a method involving the following modifications of the old method:

    a. Use of smaller propagating pieces so that there will be fewer buds to a cutting.

    b. Use of more buds or cuttings to a mother plant.

    c. Use in certain plants of parts not now used, such as leaves and roots or both leaves and roots in others.

    d. Use of materials artificially injured which usually do not bear any injury at all.

    e. Increasing injury in the propagating material by splitting the cuttings and by other means.

    f. Introduction of short intervals between vegetative generations to cause growth of sports from cells which otherwise would die or mature.

Evidences suggest that latent heritable variations exist. Evidences also showed that heritable somatic variations may be initiated by injury caused in vegetative propagation. However, no previous attempt to search for such variations and utilize them in plant improvement has been made.

An examination of the anatomy of the plant for hidden and traumatic variations is important for deciding whether or not proposed new method could become a standard in plant breeding. In the present stage of the new method, the search for evidences to support it is more important than experiment and therefore it should receive more attention than such evidences as may already have been found.

REVIEW OF PREVIOUS WORK

Soon after the new method was proposed on March 23, 1933, the work reported in this paper was begun and Dr. J. M. Capinpin of the Plant Breeding Division was asked to assign subject in this field to some of his theses students. In November of the same year, one of his students (Solpico, 1936) started an experiment to determine the variability among plants produced from root cuttings, leaf cuttings, terminal shoots, and vine cuttings of four sweet potato varieties, namely, Inube, Minaynila, Nilabanos, and Red. One half of the vine cuttings was treated by soaking them in a 0.5 per cent potassium permanganate solution for about one minute and the other half served as control. The characters studied for variability were stem color, shape and color of leaf, number of storage roots, weight of storage roots, length, diameter and weight of largest storage root, and number of rounded storage roots.

From the genetic standpoint, Solpico's most important conclusions were:

"1. The four varieties used did not show any appreciable degree of variability when propagated by root cuttings, leaf cuttings, terminal shoots, and vine cuttings.

2. Two distinct types of large bud variations were observed in plants propagated by vine cuttings. The first type consisted of a leaf variation in shape and lobing found in the four varieties. The second consisted of root variation of flesh pigmentation found in Inube variety." (See figures 1 to 4).

In Solpico's cultures, the *leaf cuttings* did not produce marketable storage roots because he harvested the plants when they were only six months old counting from the time the leaf cuttings were planted. These plants were equivalent to those only about four months old grown from vine cuttings or cuttings composed of terminal shoots. Solpico's failure to report any large variations in yield of storage roots by plants arising from leaves was not necessarily due to the absence of such variations but rather to the fact that the plants had been harvested too young.

A more detailed analysis of Solpico's unpublished data revealed that there was a tendency for certain clons to produce discontinuous variations. This conclusion was arrived at after reviewing 144 unpublished frequency distribution tables for the different characters studied. Of these tables, 16 give conspicuously discontinuous distributions. In this case, a distribution is considered discontinuous if it shows one or more classes of zero frequencies. For example, in a study of the plants produced from untreated terminal shoots of the Minaynila variety, he found the following distribution of the plants for diameter of largest root:

Class value cm.	*Frequency*
10.65	14
12.25	13
13.85	12
15.45	3
17.05	0
18.65	0
20.25	2

The discontinuous distributions shown by Solpico's data are summarized in table 1. In this table, the character checked is that in which the corresponding clon showed a discontinuous distribution.

In the frequency table referred to, the difference between any two neighboring classes is 1.60 cm. for diameter of largest root,

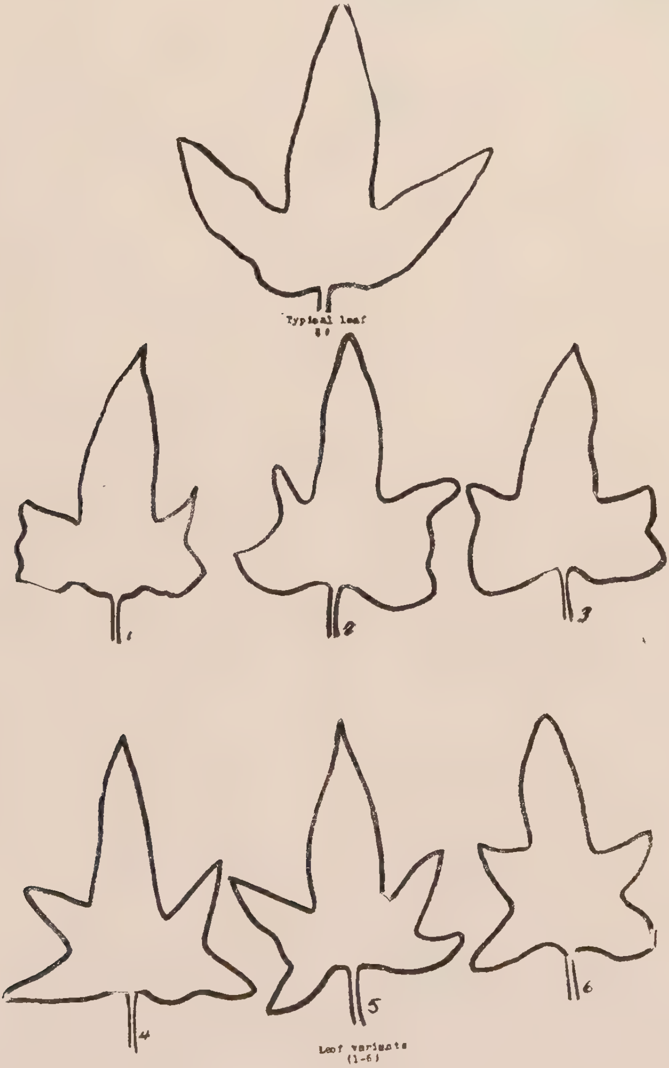

Fig. 1.—Showing the typical leaf and leaf variants (1-6) found among plants grown by vine cuttings of Inube variety.

1.2 cm. for length of largest root, 22 grams for weight of largest root, 300 grams for weight of all roots, and 4 for number of roots.

Object of the present work

This work was performed to produce plants from leaf cuttings of sweet potato and to determine if such plants would reveal any hidden or traumatic bud variations.

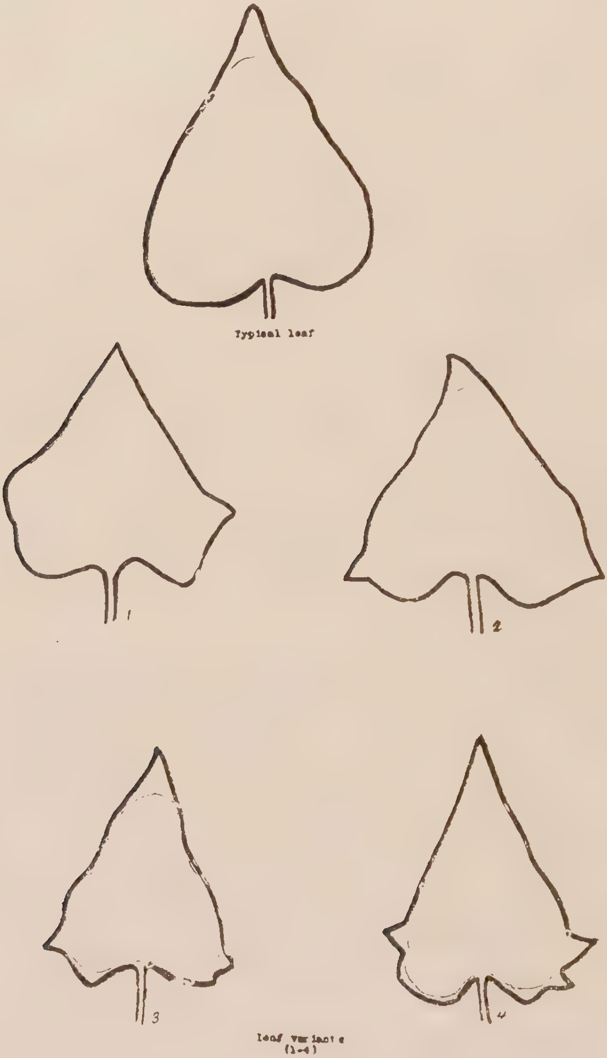

Fig. 2.—Showing the typical leaf and leaf variants (1-4) found among plants grown by vine cuttings of Nilabanos variety.

Time and place of the work

The experiments herein reported were begun on April 15, 1933, and halted on January 18, 1934. They were continued on April 17, 1936, and ended July, 1938. The cultures were grown in the author's nursery and the Plant Breeding Garden while the laboratory work was performed in his laboratory.

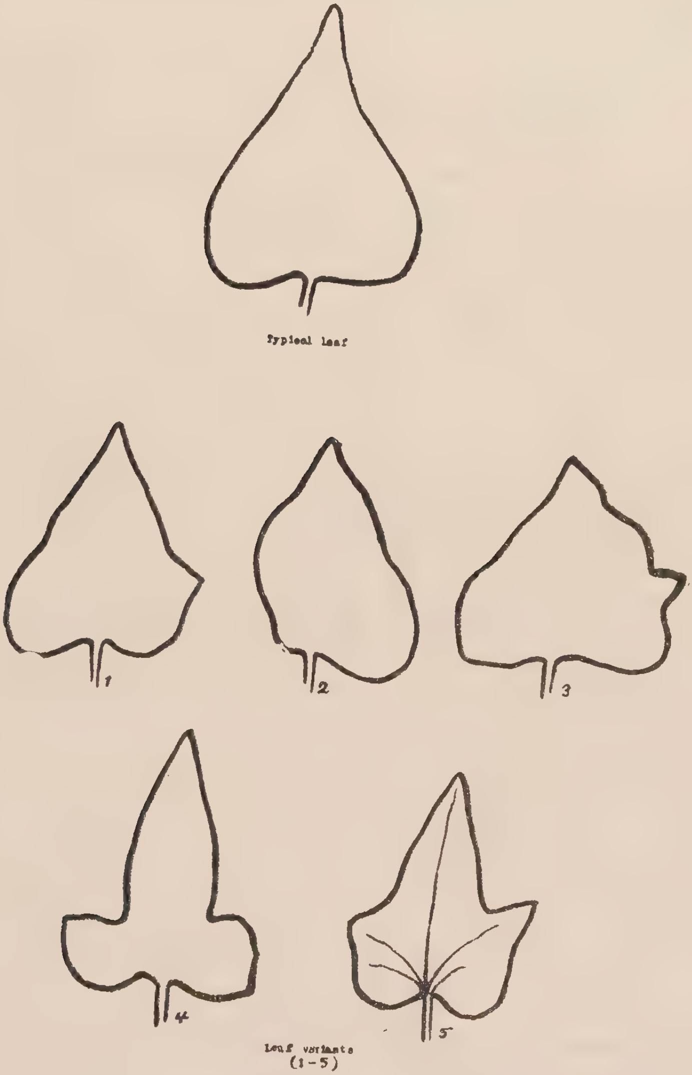

Fig. 3.—Showing the typical leaf (top) and leaf variants (1-5) found among plants grown by vine cuttings of Red variety.

MATERIALS AND METHODS

Materials. In this work as well as in the thesis assigned to Dr. Capinpin's student, sweet potato, *Ipomoea batatas* (Linn.) Poir. was used because, although this plant is usually propagated by tip

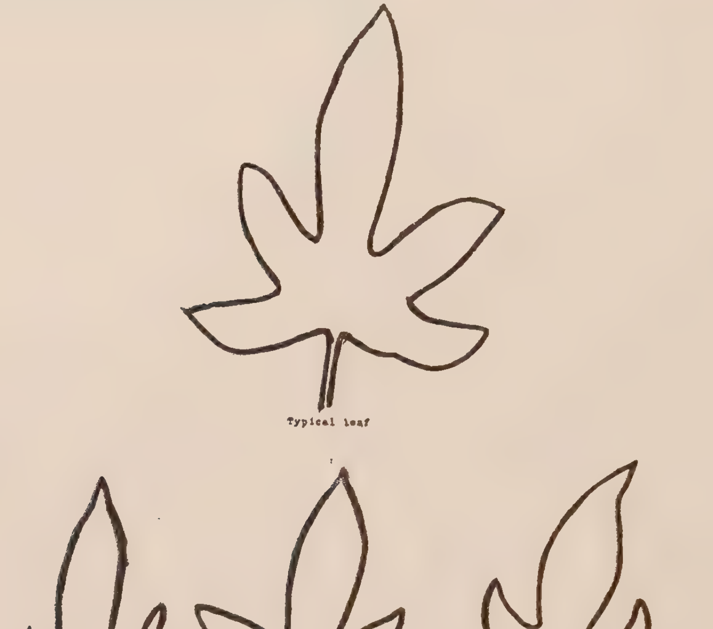

Fig. 4.—Showing the typical leaf (top) and leaf variants (1-6) found among plants grown by vine cuttings of Minaynila variety.

cuttings of the vine of stem, Isbell (1931) found that it can be propagated by leaf cuttings, even if they have no petiole or even if the blade is not entire and with or without the petiole. The sweet potato should lend itself to vegetative propagation involving use of parts not now employed and the use of materials artificially injured.

Although Isbell had already found that leaf cuttings of sweet potato have the power of regeneration, it was necessary to carry out a preliminary experiment to determine the suitability of our local materials and conditions for regeneration.

In this preliminary experiment two color varieties, one white and the other red, were used. In the main experiment, only one variety, a white one named Binurok, was employed.

The leaf cuttings for the first vegetative generation for both the preliminary and the main experiment were prepared by separating leaves of various ages from their mother stem by holding this with one hand and then exerting a combined bending and pulling force upon the petiole of each leaf with the other. While each leaf subtends a shoot bud on the stem, this bud does not go with the petiole when the leaf is separated from the stem. Hence a leaf cutting thus prepared carries no visible shoot bud. By propagating the sweet potato this way, the number of plants which can be obtained from each node of the stem is potentially doubled, and from each vine, multiplied many times. Moreover, as each leaf cutting bears a wound, each shoot arising directly from each cutting may be considered as having arisen from an injured propagating piece. To cause further injury to certain leaf cuttings, the petioles in one lot were cut crosswise by about half each without cutting the leaf blades while in another lot the petiole and the blade of each leaf were cut by about one half in the same way. For cultures of plants belonging to the second vegetative generation, planting materials were prepared consisting of stem cuttings about 40 centimeters long. The leaves and most of the petioles were removed. Eight clons composed the second generation culture. Culture of the original control was also made to serve as check. All available plantable cuttings of each clon were used. They were numbered from 25 to 100 for each clon.

Methods. Leaf cuttings were first planted immediately after they were separated from their mother stems either in ordinary seed germination boxes containing fine ordinary river sand or in specially made rooting beds of screening underlaid with coarse gravel and fine stone and provided with adobe stone walls. After the cuttings had produced shoots, they were transplanted. Those in the boxes and intended for the preliminary experiment were transplanted into ordinary nursery earthen pots, one plant to a pot, containing ordinary garden soil and those in the beds and for the first vegetative generation culture of the main experiment to the field previously prepared as for ordinary sweet potato culture.

The plants in the pots and the field were taken care of properly until they were harvested.

The cuttings used in the culture for the second vegetative generation were planted in ridges prepared in the ordinary way in a field previously occupied by corn. The ridges, or narrow beds, were about 120 centimeters apart.

The cuttings were planted singly in a slanting position. The hills were distanced one meter apart in the ridge. This culture was planted in January, 1938, and was harvested in June of the same year.

As the weather which prevailed during and after planting was rather dry for lack of rain, the entire culture was watered artificially once, the watering consisting in pouring enough water at each hill to wet the soil.

Besides number and weight of storage roots produced, the degree of sweetness of storage roots and predominating shape were studied. The degree of sweetness was determined by sampling fresh roots with a cork borer, baking the samples in an oven and then tasting them.

EXPERIMENTS AND RESULTS

Prelinary experiment to determine if sweet potato plants could be produced locally from leaf cuttings containing entire petiole and entire blade. Twenty-six leaves from one plant of the white variety and 272 leaves from 11 plants of the red variety were used for this purpose and planted in germination boxes. Four or about 15 per cent of the leaf cuttings of the red variety produced plants which were subsequently harvested. Of the culture of the red variety, twenty leaf cuttings or 7 per cent of the original number planted produced new plants. Figure 5a and 5b show two stages in the production of roots and shoot from the base of the leaf petiole. Certain leaf cuttings produced abnormalities. Some of these consisted of cuttings which rooted but produced neither shoot nor storage roots. Others produced ordinary and storage roots although they did not send out shoots (figure 6). The weight of storage roots produced by the plants in this experiment are shown in table 2.

Leaf cuttings containing entire petioles but only half portions of the leaf blades. Twenty-five leaf cuttings of the white variety were planted. Seven cuttings or 32 per cent, grew into mature plants. Table 3 gives the weight of storage roots produced in this culture.

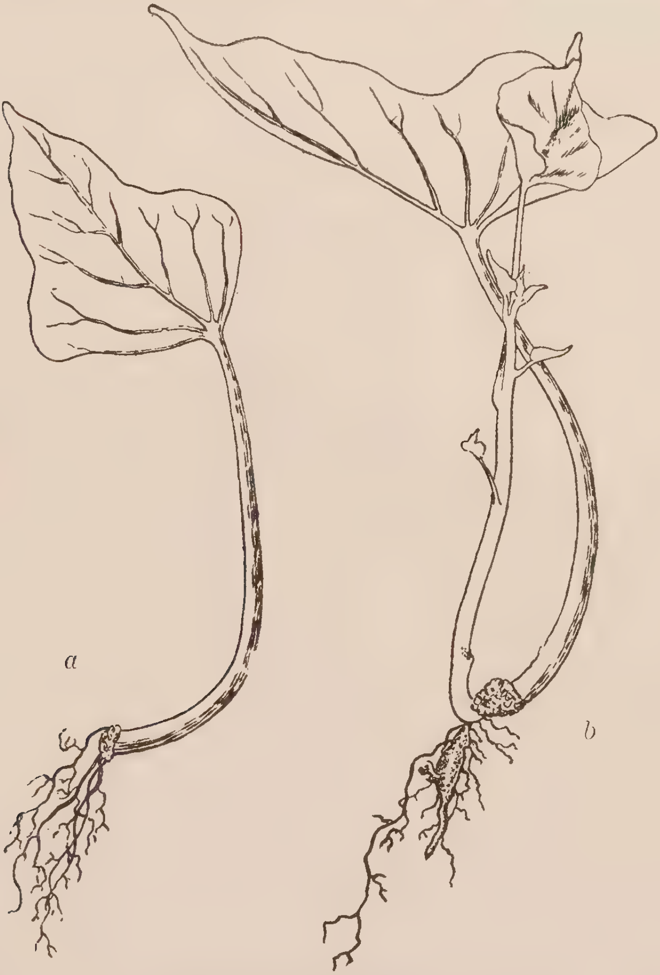

Fig. 5.—(*a*) A leaf cutting which has already produced roots but not shoot. (*b*) A cutting after producing roots and shoot.

Leaf cuttings each containing one-half portion of the leaf blade and vertical half of the petiole. Twenty-four leaves of the white variety were used. Only four leaves rooted but not a single cutting succeeded in regenerating a plant. Figure 7 shows one of these rooted cuttings.

Experiments to determine if important bud variations could be produced by propagating sweet potato by leaf cuttings. There were three of these experiments, in all of which the same variety of sweet potato, the Binurok, was used.

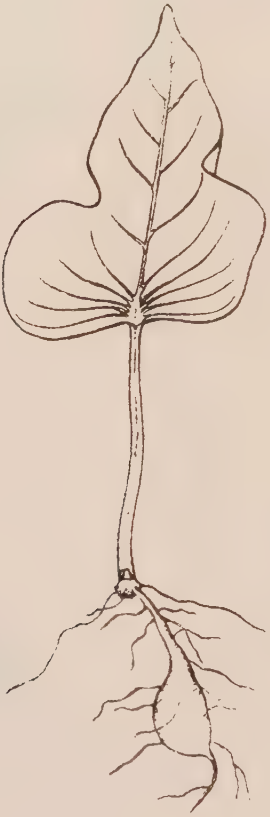

Fig. 6.—A leaf cutting which produced a small storage root but no shoot.

The first experiment consisted of a study of the plants produced in the preliminary experiments. Those plants were studied for important variations in shape of stem, color of flower, lobing of leaves, color of skin of storage roots, pigmentation of the flesh, and weight of storage roots produced. Two plants were found which produced leaves different from the mother variety in lobing and several plants produced roots with a different flesh pigmentation from the rest. The storage roots produced were abnormally small and while there were indications of large variations in yield, the plants were not seriously studied for such variations.

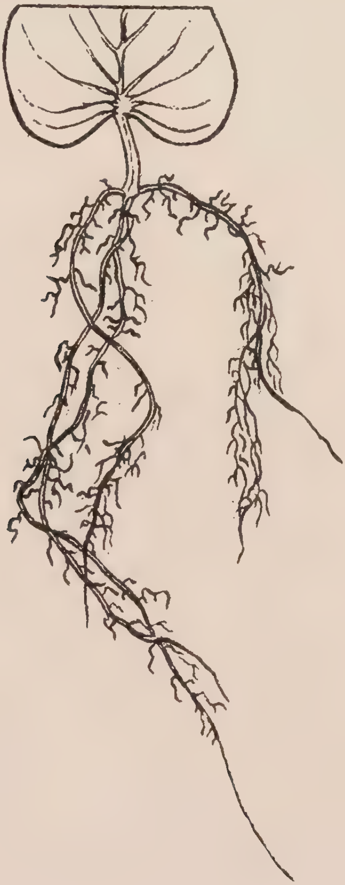

Fig. 7.—A leaf cutting with half of its leaf blade and petiole removed produced roots but no shoot.

In the second experiment, 600 leaves separated from six different plants and containing entire petioles and entire blades were planted in a seed bed on April 17, 1936. By July 7 of the same year those cuttings that had produced new plants had sufficiently long shoots to be transplanted in the field. Of 600 leaf cuttings planted, 80 or about 13 per cent produced plants. These were harvested on January 16, 1937. The results of this test are shown in table 4. Figure 8 shows the different shapes of storage roots found among those produced by plants from different kinds of cuttings as well as the typical shape of roots of the original stock. The letters contained in the last column of table 4 as well as in the two other tables immediately following refer to letters designating different root shapes shown in figure 8.

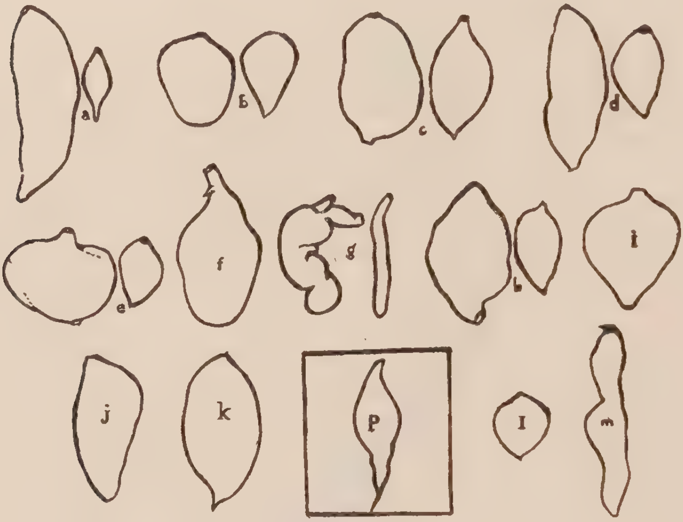

Fig. 8.—a-m. Typical shape of storage roots of different plants grown from leaf cuttings and of the parent variety (p).

In the third experiment 700 leaf cuttings of the same white variety each leaf containing entire petiole but only half of the blade, were planted in a seed bed on April 17 and 18, 1936. A little over 9 per cent of these cuttings produced plants. These were transplanted in the field on July 7 of the same year and harvested on January 16, 1937. The results of this planting are summarized in table 5.

For control, a number of tip cuttings of vines of the mother variety were planted on July 7, 1936, and harvested January 16, 1937. The results of this planting are given in table 6.

The yields in tables 4, 5, and 6 are summarized in frequency distribution in table 7. To give some idea of the variations produced by plants arising from cuttings as compared with plants grown from true seeds of sweet potato, the yields of the plants which were raised from seeds by the author many years ago (Mendiola, 1921) in an attempt to produce heritable variabilities were included in this table. Moreover, the variation in shape of leaf found among seedling offspring of Samar Big Yellow variety was reviewed and compared with those found by Solpico. While the varieties involved in the comparison are different, still the results give some idea of what might be expected in the way of variations in this character.

Experiment to determine the yield of plants grown from vine cuttings and plants grown from leaf cuttings. The results of the culture of plants of the second vegetative generation are shown in table 8 and table 9. In order to determine the constancy of the variations observed in the first vegetative generation, the clons which survived the second generation planting were ranked according to their yields in the two generations studied. These comparisons of ranks are shown in table 8. Table 9 gives the results of the planting of second generation vine cuttings of the control.

DISCUSSION OF RESULTS

Possibility of propagating local sweet potato varieties by leaf cuttings. The results of this work as well as Solpico's have proved that some local varieties of sweet potato can be propagated by leaf cuttings even if the blade of the leaf is partially removed, provided the petiole is left intact. It is quite probable that most, if not all, varieties of sweet potato in the Philippines may also be propagated similarly. In case of necessity we have in propagation by leaf cuttings a good supplementary method for more rapid propagation of sweet potato plants.

Percentage of cutting giving rise to new plants. In Solpico's work the percentage obtained was 27 in one case and 92 in the other. In the present work, 7, 9, 13, and 15 per cent were obtained. It appears from these results that to be able to raise the number of plants from leaf cuttings that would be adequate for statistical work, it would be necessary to plant large numbers of leaf cuttings.

It is interesting to point again to the fact that among leaf cuttings that did not produce shoots, there were those that exhibited some kinds of abnormalities, such as the production of storage roots direct from cuttings which failed to produce new plants.

Harvesting age of plants grown from leaf cuttings. The difference in harvesting age between plants grown from ordinary vine cuttings and those from leaf cuttings is approximately the length of time that it takes the shoot produced by the leaf cuttings to reach the length of the vine cuttings which are commonly used in ordinary cultures. This time varied in the different experiments reported in this paper from 30 to 100 days; the average was 70 days.

Evidence of hidden variations. The results obtained from this work show a slight evidence of the existence in the original mother plants used of variations large enough for selection purposes. These variations were found in lobing of leaf, color of flesh of storage roots, and yield of storage roots. In seedling tests performed by the author many years ago (Mendiola, 1921), the highest yield of seedling plant obtained was 2.333 kilograms in the case of a seedling plant of Binandera variety and 2.802 kilograms in that of a seedling plant of Samar Big Yellow. In the present work, one of the plants grown from leaf cuttings produced 2.70 kilograms of storage roots. The important variations, therefore, in the case of plants grown from leaf cuttings, need not be less than those of plants from true seeds.

As to evidence of traumatic variations it is necessary to refer to figures in the second, third, and fourth columns of table 7. It will be noted that the plants from entire-leaf cuttings produce a higher standard deviation in yield than either the control or those from leaf cuttings which were deprived of half of their blades, the last two producing approximately the same standard deviation. Considering that half-bladed cuttings received wound twice and therefore were expected to give a more variable population than either the control or the entire-leaf cuttings, it is quite probable that no traumatic variation was produced.

Heritability of yield variations. In order to determine whether there was any evidence obtained of inheritance of variations shown by plants from different kinds of cuttings, the yield ranks of the plants in the first and second vegetative generations as shown in table 8 were studied. It would seem that very little of such evidence was secured. The first ten ranking plants in the first generation were not all first ranking ones in the second generation except in two cases in which the seventh in rank in the first generation was the third in the second generation, and the tenth in the first turned out to be the ninth. Similarly, the last ten ranking in the first generation were not all in the last ten rungs of the ladder, except in three cases.

It is to be regretted that the highest yielding individual in the first generation, which was plant R5H1 and which gave a yield of 2.70 kilograms of storage roots, died and did not reach the second generation, for this was the only plant which might be considered as a sudden variation and should have shown inheritance of yield characteristic in the second generation. This is the second time in sweet potato breeding work that the author discovered that a sweet potato plant representing a sudden variation in yield character failed to survive in the second generation. The first case was that of a Samar Big Yellow seedling plant which produced a yield of 2.802 kilograms of roots, the highest yield among 205 plants and representing clearly a sudden variation as shown in the bottom of the fifth column of table 7.

While the results obtained in the second generation show little if any evidence of inheritance of the variations produced by plants from leaf cuttings, they do not necessarily disprove the existence of hidden variations. In the first place it has just been explained that the very plant which might have been expected to show constancy of characters died before it was able to produce offspring. In the second place, reversions of bud variations are evidently so common that if a bud variation is produced in one generation by leaf propagation and disappears in the other, the phenomenon can not be considered as unusual. This will be discussed by the author in a report which is under preparation.

SUMMARY AND CONCLUSIONS

In this paper a report is made of the success of producing sweet potato plants from leaf cuttings, with entire blade and petiole or with vertical half of the blade removed. Leaf cuttings with vertical half of the petiole removed failed to produce new plants.

The plants produced from leaf cuttings showed evidence of hidden bud variations, some of which may be considered discontinuous, and slight evidence of traumatic bud variations produced as a result of the wound caused by separating the petiole from the stem of the mother plant in the preparation of the leaf cuttings.

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TABLE 1

Showing the different sweet potato clons and the characters, those checked, in which they gave certain discontinuous distribution among different classes

VARIETY AND CLONS	CHARACTERS STUDIED					
	Number of storage roots	Weight of storage roots	Diameter of largest storage roots	Weight of largest storage roots	Length of largest storage roots	Number of rounded storage roots
Inube						
Root cuttings *T* [a]						
N. T.						
Terminal shoots *T.* ..					√	
N. T.					√	
Vine cuttings *T*						
N. T.			√			
Minaynila						
Root cuttings *T*	√			√		
N. T.						
Terminal shoots *T.* ..					√	
N. T.			√	√		
Vine cuttings *T*			√			
N. T.		√	√			
Nilabanos						
Root cuttings *T*						
N. T.			√			
Terminal shoots *T.* ..					√	
N. T.						
Vine cuttings *T*			√			
N. T.						
Red						
Root cuttings *T*					√	
N. T.						
Terminal shoots *T.* ..						
N. T.						
Vine cuttings *T*						
N. T.						

[a] *T.* means treated and *N. T.* not treated.

TABLE 2

Yield of plants from leaf cuttings planted March 15, 1933, with entire petioles and entire blades, potted June 20, 1933, and harvested January 15, 1934

WHITE VARIETY

PLANT DESIGNATION	WEIGHT OF STORAGE ROOTS PRODUCED
	grams
1	125.9
2	89.0
3	101.9
4	86.4
RED VARIETY	
1	17.4
2	58.0
3	76.6
4	50.0
5	79.6
6	50.5
7	39.7
8	99.8
9	59.7
10	84.5
11	47.8
12	34.3
13	35.6
14	54.3
15	44.0
16	25.2
17	70.5
18	59.6
19	56.6
20	61.5

TABLE 3

Yield of plants from leaf cuttings of white variety planted on March 15, 1933, with entire petioles but with half blades, potted June 20, 1933, and harvested January 15, 1934

PLANT DESIGNATION	WEIGHT OF STORAGE ROOTS PRODUCED
	grams
1	109.9
2	50.0
3	88.5
4	92.3
5	23.1
6	68.3
7	54.4
Control vine cutting	103.9

TABLE 4

Yield and characters of storage roots of plants from leaf cuttings of Binurok sweet potato planted April 17, 1936, with entire petiole and entire blade, in a germinating bed, transplanted in the field July 7, 1936, and harvested January 16, 1937

PLANT NO.	PEDIGREE DESIGNATION	NUMBER OF STORAGE ROOTS	WEIGHT OF STORAGE ROOTS	TASTE OF BAKED SAMPLE	SHAPE OF STORAGE ROOTS [d]
			kgm.		
1	R6H1	1	0.16	s [a]	d
2	R2H1	3	0.24	ns [b]	d
3	R6H3	3	0.26	fs [c]	e
4	R6H5	4	0.28	fs	e
5	R2H8	5	0.29	ns	g
6	R1H11	3	0.31	ns	i
7	R7H2	8	0.35	ns	j
8	R1H4	4	0.37	ns	c
9	R6H12	4	0.37	fs	b
10	R3H7	6	0.38	ns	b
11	R3H5	3	0.39	ns	j
12	R3H9	7	0.39	s	c
13	R3H8	3	0.42	ns	g
14	R6H8	3	0.46	ns	b
15	R7H7	3	0.46	ns	b
16	R1H7	1	0.47	ns	f
17	R2H11	1	0.50	ns	b
18	R7H4	3	0.52	ns	b
19	R2H4	4	0.54	fs	c
20	R5H2	4	0.55	s	a
21	R5H8	5	0.56	ns	i
22	R4H11	6	0.57	ns	f
23	R1H6	6	0.58	ns	f
24	R1H9	5	0.59	ns	j
25	R3H11	7	0.61	fs	b
26	R2H5	5	0.62	ns	e
27	R3H12	3	0.65	ns	b
28	R4H9	11	0.69	fs	b
29	R4H10	9	0.72	fs	b
30	R5H7	4	0.72	fs	e
31	R1H3	5	0.73	fs	
32	R2H9	3	0.73	ns	e
33	R6H9	7	0.73	ns	c
34	R7H6	8	0.73	s	a
35	R3H10	8	0.74	fs	h
36	R6H11	2	0.79	ns	e
37	R2H12	1	0.81	ns	b

[a] s—sweet.

[b] ns—not sweet.

[c] fs—fairly sweet.

[d] See figure 8 for shape designations.

TABLE 4 (continued)

PLANT NO.	PEDIGREE DESIGNATION	NUMBER OF STORAGE ROOTS	WEIGHT OF STORAGE ROOTS	TASTE OF BAKED SAMPLE	SHAPE OF STORAGE ROOTS
			kgm.		
38	R1H10	2	0.85	ns	e
39	R1H12	5	0.85	fs	b
40	R2H6	9	0.85	ns	b
41	R4H12	3	0.85	ns	b
42	R5H11	4	0.85	ns	c
43	R6H7	10	0.85	ns	f
44	R6H10	11	0.85	ns	a
45	R7H1	9	0.85	ns	h
46	R5H5	3	0.88	ns	c
47	R1H13	2	0.89	ns	b
48	R2H10	5	0.90	ns	c
49	R1H2	4	0.93	ns	e
50	R7H3	12	0.96	ns	d
51	R3H2	10	0.97	ns	b
52	R1H8	6	0.99	ns	i
53	R4H8	6	1.03	ns	d
54	R5H6	9	1.15	ns	b
55	R3H1	11	1.19	ns	d
56	R3H3	5	1.25	ns	k
57	R5H4	7	1.27	ns	c
58	R1H5	5	1.35	ns	f
59	R2H2	9	1.38	ns	c
60	R4H7	10	1.39	ns	b
61	R4H6	10	1.57	ns	b
62	R5H3	8	1.62	fs	b
63	R1H1	14	1.74	ns	k
64	R7H5	8	1.82	ns	b
65	R5H1	15	2.70	ns	c
Total		380	52.06		
Average		5.85	0.80		

TABLE 5

Yield and characters of storage roots of plants from leaf cuttings of Binurok variety planted in a seed bed on April 17 and 18, 1936, with entire petiole but with only half blade, transplanted in the field July 7, 1936, and harvested January 16, 1937

PLANT NO.	PEDIGREE DESIGNATION	NUMBER OF STORAGE ROOTS	WEIGHT OF STORAGE ROOTS	TASTE OF BAKED SAMPLE	SHAPE OF STORAGE ROOTS
			kgm.		
66	R12H11	1	0.07	s	l
67	R12H3	3	0.18	fs	j
68	R13H1	1	0.25	s	b
69	R12H4	3	0.26	ns	i
70	R10H10	2	0.31	ns	e
71	R10H3	3	0.33	ns	d
72	R8H9	2	0.34	ns	d
73	R10H11	2	0.35	ns	a
74	R11H7	2	0.36	fs	a
75	R13H11	3	0.36	fs	a
76	R12H2	4	0.40	fs	d
77	R12H8	5	0.43	ns	e
78	R10H2	1	0.45	ns	e
79	R12H6	3	0.45	s	b
80	R8H5	8	0.47	ns	c
81	R11H10	3	0.48	ns	e
82	R11H8	8	0.50	ns	a
83	R11H11	1	0.50	s	e
84	R8H1	4	0.52	fs	d
85	R9H5	4	0.52	fs	l
86	R12H9	4	0.55	fs	l
87	R10H4	3	0.56	ns	f
88	R11H5	4	0.56	very sweet	f
89	R13H10	4	0.56	fs	f
90	R9H11	3	0.57	fs	e
91	R9H1	6	0.58	fs	a
92	R11H9	2	0.63	fs	b
93	R12H7	3	0.64	fs	f
94	R11H2	6	0.65	s	a
95	R9H10	6	0.66	s	e

TABLE 5 (continued)

PLANT NO.	PEDIGREE DESIGNATION	NUMBER OF STORAGE ROOTS	WEIGHT OF STORAGE ROOTS	TASTE OF BAKED SAMPLE	SHAPE OF STORAGE ROOTS
			kgm.		
96	R11H3	5	0.66	fs	k
97	R8H7	4	0.67	bitter	b
98	R10H1	2	0.67	ns	c
99	R14H2	5	0.67	ns	f
100	R8H6	8	0.68	fs	i
101	R9H6	3	0.68	fs	e
102	R8H4	6	0.71	ns	l
103	R9H8	5	0.71	ns	d
104	R13H5	5	0.72	fs	a
105	R13H7	5	0.73	ns	a
106	R8H8	9	0.74	ns, tough	a
107	R8H3	5	0.75	ns	c
108	R10H5	6	0.75	ns	d
109	R11H6	6	0.78	ns	e
110	R12H5	4	0.78	fs	k
111	R9H3	6	0.81	vs	i
112	R8H2	4	0.83	ns	h
113	R9H9	7	0.83	ns	c
114	R13H9	4	0.85	s	e
115	R9H7	5	0.90	fs	b
116	R13H8	3	0.90	s	a
117	R9H2	4	0.93	s	a
118	R11H4	3	0.93	ns	c
119	R13H2	7	1.02	s	f
120	R9H4	10	1.10	ns	b
121	R13H3	10	1.11	s	b
122	R10H6	7	1.17	ns	c
123	R13H6	4	1.25	ns	a
124	R14H3	11	1.31	ns	e
125	R14H1	9	1.45	ns	e
Total		279	40.12		
Average		4.65	0.67		

TABLE 6

Yield and characters of storage roots of plants from ordinary tip cuttings of vines of Binurok variety planted directly in field on July 7, 1936, and harvested January 16, 1937

PLANT NO.	PEDIGREE DESIGNATION	NUMBER OF STORAGE ROOTS	WEIGHT OF STORAGE ROOTS	TASTE OF BAKED SAMPLE	SHAPE OF STORAGE ROOTS
			kgm.		
126	R16H3	1	0.16	ns	m
127	R16H1	3	0.44	s	k
128	R15H3	3	0.52	fs	f
129	R16H5	5	0.54	fs	b
130	R15H4	8	0.55	fs	k
131	R16H4	8	0.55	s	a
132	R16H2	4	0.57	fs	e
133	R15H2	4	0.62	ns	f
134	R15H10	7	0.63	fs	a
135	R16H9	2	0.67	fs	e
136	R16H6	12	0.74	s	a
137	R16H8	6	0.75	fs	b
138	R16H10	9	0.85	ns	l
139	R15H1	4	0.89	ns	a
140	R15H7	6	1.03	fs	f
141	R15H8	3	1.06	ns	l
142	R15H6	8	1.09	fs	f
143	R16H7	7	1.10	ns	e
144	R15H5	3	1.27	ns	e
145	R15H9	11	1.35	ns	b
Total		114	15.38		
Average		5.7	0.77		

TABLE 7

Frequency distribution of yields of storage roots of plants grown from different kinds of sweet potato cuttings and from seeds (summary of tables 4, 5, and 6)

CLASS VALUE	FREQUENCY								
	From leaf cuttings			From seeds					
	With entire petiole and entire blade	With entire petiole but with half blade	Vine cuttings	Samar Big Yellow	Binglo	Binandera	Boled Zaailing	Unknown C	Unknown D
Kgm.									
0-0.10	—	1	—	124	41	3	5	3	5
0.11-0.30	5	3	1	58	32	2	6	4	5
0.31-0.50	12	14	1	11	14	3	1	2	3
0.51-0.70	11	18	8	5	6	0	—	—	1
0.71-0.90	20	15	4	2	2	0	—	—	—
0.91-1.10	5	4	4	2	—	1	—	—	—
1.11-1.30	4	3	1	1	—	0	—	—	—
1.31-1.50	3	2	1	1	—	0	—	—	—
1.51-1.70	2	—	—	0	—	0	—	—	—
1.71-1.90	2	—	—	0	—	0	—	—	—
1.91-2.10	0	—	—	0	—	0	—	—	—
2.11-2.30	0	—	—	0	—	0	—	—	—
2.31-2.50	0	—	—	0	—	0	—	—	—
2.51-2.70	1	—	—	0	—	1	—	—	—
2.71-2.90	—	—	—	1	—	—	—	—	—
Total ..	65	60	20	205	95	10	12	9	14
Mean ..	0.80 ± 0.03	0.67 ± 0.024	0.77 ± 0.041	0.16 ± 0.007	0.20 ± 0.012	0.52 ± 0.14	0.15 ± 0.019	0.19 ± 0.029	0.22 ± 0.029
Standard deviation	0.37 ± 0.021	0.28 ± 0.017	0.27 ± 0.023	0.15 ± 0.005	0.18 ± 0.008	0.68 ± 0.104	0.10 ± 0.013	0.13 ± 0.019	0.16 ± 0.020

TABLE 8

A comparison of yields and of ranks of plants grown from leaf cuttings with their corresponding vegetative offspring grown from ordinary cuttings

LIST NUMBER OF PLANT	ORIGINAL RANK	PEDIGREE NUMBER	ORIGINAL YIELD OF PLANT	AVERAGE YIELD PER PLANT FROM ORDINARY CUTTING	NEW RANK BASED ON SECOND CULTURE
1	1	R7H5	1.82	0.31	32
2	2	R5H3	1.62	0.28	35
3	3	R14H1	1.45	0.12	45
4	4	R4H7	1.39	0.42	25
5	5	R2H2	1.38	0.40	27
6	6	R14H3	1.31	0.23	39
7	7	R5H4	1.27	1.08	3
8	8	R13H6	1.25	0.66	11
9	9	R10H6	1.17	0.18	42
10	10	R13H3	1.11	0.68	9
11	11	R9H4	1.10	0.32	31
12	12	R4H8	1.03	0.25	38
13	13	R13H2	1.02	0.48	20
14	14	R3H2	0.97	0.58	15
15	15	R9H2	0.93	0.40	27
16	15	R11H4	0.93	0.37	28
17	16	R2H10	0.90	0.14	44
18	16	R9H7	0.90	0.47	21
19	16	R13H8	0.90	0.75	5
20	17	R5H5	0.88	0.27	36
21	18	R4H12	0.85	0.30	33
22	18	R5H11	0.85	0.57	16
23	18	R6H7	0.85	0.14	44
24	18	R13H9	0.85	0.26	37
25	19	R9H3	0.81	0.36	29
26	20	R6H11	0.79	0.37	28
27	21	R12H5	0.78	0.53	18
28	22	R8H3	0.75	0.45	22
29	22	R10H5	0.75	0.37	28
30	23	R8H8	0.74	0.40	27
31	24	R6H9	0.73	0.30	33
32	24	R7H6	0.73	0.47	21
33	25	R4H10	0.72	0.42	25
34	25	R5H7	0.72	0.10	46
35	25	R13H5	0.72	0.67	10
36	26	R9H8	0.71	0.54	17
37	27	R4H9	0.69	0.71	8
38	28	R8H6	0.68	0.63	13
39	28	R9H6	0.68	0.50	19
40	29	R8H7	0.67	0.33	30
41	29	R10H1	0.67	0.14	44
42	29	R14H2	0.67	0.27	41
43	30	R9H10	0.66	0.43	24
44	30	R11H3	0.66	0.44	23
45	31	R11H2	0.65	0.17	43
46	32	R12H7	0.64	0.47	21
47	33	R11H9	0.63	0.26	37
48	34	R3H11	0.61	0.25	38
49	35	R1H6	0.58	0.30	33
50	36	R4H11	0.57	0.47	21

TABLE 8 (Continued)

LIST NUMBER OF PLANT	ORIGINAL RANK	PEDIGREE NUMBER	ORIGINAL YIELD OF PLANT	AVERAGE YIELD PER PLANT FROM ORDINARY CUTTING	NEW RANK BASED ON SECOND CULTURE
51	37	R13H10	0.56	0.30	33
52	37	R11H5	0.56	0.64	12
53	38	R5H2	0.55	0.32	31
54	38	R12H9	0.55	0.73	7
55	39	R8H1	0.52	0.74	6
56	40	R11H11	0.50	0.59	14
57	41	R11H10	0.48	0.47	21
58	42	R1H7	0.47	0.45	22
59	42	R8H5	0.47	0.22	40
60	43	R7H7	0.46	0.23	39
61	44	R3H5	0.39	1.51	1
62	44	R3H9	0.39	0.30	33
63	45	R3H7	0.38	0.81	4
64	46	R1H4	0.37	0.20	41
65	47	R11H7	0.36	0.41	26
66	47	R13H11	0.36	0.36	29
67	48	R7H2	0.35	1.11	2
68	49	R10H3	0.33	0.29	34
69	50	R2H8	0.29	0.25	38
70	51	R12H4	0.26	0.41	26
71	52	R6H1	0.16	0.32	31
Total			53.50	30.67	
Average			0.75	0.43	

TABLE 9

Average yield of storage roots per plant of second generation culture of the mother variety

CLON NUMBER	YIELD PER PLANT
	kgm.
R15H1	0.40
R15H3	0.08
R15H6	0.20
R15H7	0.27
R15H8	0.27
R15H9	0.20
R15H10	0.10
R16H6	0.18
R16H7	0.30
R16H9	0.30
Label lost	0.36
Label lost	1.09
Average	0.31

STUDIES ON THE PLANE OF NUTRITION OF FAMILIES OF LABORERS IN CALABANGA, CAMARINES SUR[1]

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Calabanga is a town in Camarines Sur Province with a population of 8,236. It is bounded on the north by San Miguel Bay and the Municipality of Tinambac; on the east, by Mt. Isarog and the Municipality of Tinambac; on the south, by the Municipality of Magsarao; and on the west, by the Municipality of Cabusao and the Bicol River. The chief occupations of the inhabitants are fishing and farming. Dr. Francisco Gomez, District Health Officer of Camarines Sur, considers the food of the people in this town as not far from being typical of the food of the working class in the province.

The inventory method (Morey, 1933), the same method used in a previous work, (Santos, Villanueva, and Silva, 1936) was employed. The actual collection of data was made from April 3 to June 17, 1936, by Mr. Gregorio del Valle, a sanitary inspector of Dr. Francisco Gomez. Dr. Gomez furnished some of the transportation and other facilities needed in the work.

One portable "True-Way" scale having a maximum capacity of 250 pounds was used in taking the individual weights. Another one, a handy "Columbus" scale having a maximum capacity of one kilogram was used in weighing the different food materials.

Data on food consumed by from one to four families were taken daily for luncheon, supper, and breakfast. The kinds of food materials and amounts cooked for each meal were recorded. In most cases there were no left-overs of the food prepared, except rice. It was calculated that left-overs did not amount to more than 10 per cent of the whole food for the day. The number of individuals who ate at each meal and their ages and weights in ordinary clothing were also recorded.

The proximate analyses of food materials were taken from Valenzuela (1928), Santos and Adriano (1929), Santos and Ascalon

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(1931), Hermano (1934) and from the records of the Experiment Station Section of this Department.

The standard prepared by Lusk (1928) for the Paris meeting of the "The Interallied Scientific Food Commission" on March, 1918, was used to determine the number of man units in each family. Breast-fed infants were not included. The standard follows:

Age in years	*Coefficients*
0–6 (Both sexes)	0.50
6–10 (Both sexes)	0.70
10–14 (Both sexes)	0.83
14+ (Males)	1.00
14+ (Females)	0.83

RESULTS AND SUMMARY

Some of the results are given in tables 1 to 6. These results may be summarized as follows:

1. An inventory of the food of one hundred sixty-five families of laborers in Calabanga, Camarines Sur, was made.

2. The oldest man was 110 years old and the oldest woman was 85. Out of 260 men there were 20 over sixty years, and of 268 women, 21 were over 60 years.

3. The heaviest man weighed 70 kilos and the heaviest woman, 60. The average weight of men over 14 years of age was 52 kilos.

4. There was an average of 4.72 persons in a family.

5. The daily food per man unit cost from 6 to 22 centavos, with an average of 12 centavos.

6. The most common food materials besides rice, were "bagoong" (salted small shrimps), coconut, fresh and dried fish, banana, kamias (*Averrhoa bilimbi* Linn.), sweet potato tuber and leaves, gabi leaves (*Colocasia esculentum* (Linn.) Schott), tomatoes, kalamondin (*Citrus mitis* Blanco) shrimp, malungay (*Moringa oleifera* Lam.) and kangkong (*Ipomoea reptans* (Linn.) Poir.).

7. The average daily intake per man unit was: proteins, 70 ± 1.01 grams; fats, 33 ± 1.11 grams; minerals, 16 ± 0.31 grams; carbohydrates, 564 ± 6.78 grams; and calories, 2895 ± 35.54. The fat, carbohydrate, and caloric intake were greater than those in Sta. Catalina, in Paoay and in Pototan. The protein was the same as in Paoay and greater than that in Sta. Catalina and in Pototan. The salt was greater than in Pototan but less than that in Sta. Catalina and in Paoay.

8. It has been estimated (Santos and Adriano, 1928) that an average adult Filipino should have the following daily intake: proteins, 80 grams; fats, 40 grams; carbohydrates, 450 grams and calories 2500. From table 1, it may be seen that out of 165 families, 71, or 43 per cent, had a daily man unit protein intake of 70 grams or more; 87 families, or 53 per cent, fat intake of 30 grams or more; only 5 families, or 3 per cent, had a carbohydrate intake of less than 350 grams; and only 9 families or 5 per cent had a caloric intake of less than 2000.

9. Coconut was a popular food. In 92 families it furnished 69 per cent of the fat and 11.6 per cent of the total caloric intake.

10. Cereals furnished 79 per cent of the daily caloric intake; fruits and vegetables, 13 per cent; meat, fish, and eggs, 4 per cent; sweet and fatty foods, 3 per cent; milk and other dairy products, almost nil.

11. The average caloric intake (56) per kilogram body weight was higher than the corresponding intake of other Filipino groups; higher even than the intake of American, German, and Japanese. But proteins furnished only 9.9 per cent of the total calories. It is generally accepted that proteins should furnish from 10 to 15 per cent of the total calories.

12. The average protein intake (1.35 gms.) per kilogram body weight was lower than the corresponding intake of American, German, and Japanese. Seventy per cent of the proteins were of plant origin. Rice alone furnished 63 per cent of the proteins.

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TABLE 1

Food intake and distributions of families

Proteins

INTAKE	NO. OF FAMILIES	PER CENT
gms.		
Below 50	21	13
50 – 59	33	20
60 – 69	40	24
70 – 79	25	15
80 – 89	19	12
90 or above	27	16
	Fats	
gms.		
Below 10	19	11
10 – 19	41	25
20 – 29	18	11
30 – 39	26	16
40 – 49	25	15
50 or above	36	22
	Carbohydrates	
gms.		
Below 350	5	3
350 – 449	22	13
450 – 549	52	32
550 – 649	53	32
650 – 749	18	11
750 or above	15	9
	Calories	
gms.		
Below 2000	9	5
2000 – 2499	41	25
2500 – 2999	53	32
3000 – 3499	31	19
3500 – 3999	21	13
4000 or above	10	6

TABLE 2

Average intake per man unit per day

FAMILIES	PROTEINS	FATS	CARBOHYDRATES	SALTS	FUEL VALUE
	grams	*grams*	*grams*	*grams*	*calories*
Sta. Catalina [c] .	60±1.69	15±0.92	456±11.54	24±0.92	2193±51.34
Paoay [c]	70±1.56	25±1.28	443±10.38	29±1.47	2387±49.71
Pototan [c]	54±0.37	13±0.20	370± 2.94	8±0.14	1831±11.95
Calabanga	70±1.01	33±1.11	564± 6.78	16±0.31	2895±35.54
			Differences		
C–Sta. Catalina	10±1.97	18±1.44	108±13.38	— 8±0.97 [a]	702±62.44
C–Paoay	0	8±1.69	121±12.40	—13±1.50 [b]	508±61.11
C–Pototan	16±1.08	20±1.13	194± 7.39	8±0.34	1064±37.49

[a] In favor of Sta. Catalina.
[b] In favor of Paoay.
[c] Santos, Villanueva, and Silva, 1936.

TABLE 3

Showing comparative food intake

	PROTEINS	FATS	CARBO-HYDRATES	ASH	CALORIES
	grams	*grams*	*grams*	*grams*	
Bilibid prisoners (Aron, 1909)	75	27	510		2647
Bilibid prisoners (Concepcion, 1919)	53	15	352		1799
C. A. Students (Roxas and Collado, 1922)	78	38	506	14	2675
Farmers—Los Baños (Roxas and Collado, 1922)	70				2247
Filipino Students at Yale (Santos, 1923)	78				2090
Male Students, U. P. Manila (Concepcion, 1933)	83	42	374		2317
Beriberic families—Cavite & Nueva Ecija (Santos, unpublished)	64	16	452		2260
C. A. Students (Samia, 1930)	82				
Filipino Olympic Athletes (Collado and Santos, 1932)	114	81	494	15	3246
Bilibid Prisoners (Santos and Pidlaoan, 1933)	91	49	602	25	3300
Laborers of Government Institution (Concepcion, 1933)	75	35	519		2763
Boys at Welfareville (Santos and Pidlaoan, 1937)	86	48	418	17	2505
Families in Tañgos, Rizal (Aycardo, unpublished)	53	18	309		1613
Sta. Catalina, Ilocos Sur (Santos, Villanueva, and Silva, 1936)	60	15	456	24	2193
Paoay, Ilocos Norte (Santos, Villanueva and Silva, 1936)	70	25	443	29	2387
Pototan, Iloilo (Santos, Villanueva, and Silva, 1936)	54	13	370	8	1831
Calabanga Camarines Sur (Present study)	70	33	564	16	2895
Japanese (Grey, 1928)	89	18	538		2732
Javanese (Langworthy, 1911)	73				2500
Chinese (Langworthy, 1911)	91				3400

TABLE 4

Comparative food intake per kilo body weight and calories from protein

	PC/TC	P/KBW	C/KBW
	per cent	*grams*	*calories*
Bilibid prisoners (Aaron, 1909)	11.7	1.50	41
Bilibid prisoners (Concepcion, 1919)	12.1	1.06	35
C. A. Students (Roxas and Collado, 1922)	11.9	1.56	54
Farmers—Los Baños (Roxas and Collado, 922)	12.9	1.40	45
Filipino Students at Yale (Santos, 1923)	15.2	1.56	45
Male Students, U. P. Manila (Concepcion, 1933)	14.7	1.66	44
Beriberic familits—Cavite & Nueva Ecija (Santos, unpublished)	11.6	1.28	45
Filipino Olympic Athletes (Collado and Santos, 1932)	14.3		
Bilibid Prisoners (Male) Santos and Pidlaoan, 1933)	11.3		
Laborers of Government Institution (Concepcion, 1933)	11.1	1.50	55
Boys at Welfareville (Santos and Pidlaoan, 1937)	14.0		
Families in Tañgos, Rizal (Aycardo, unpublished)	13.4		
Sta. Catalina, Ilocos Sur (Santos, Villanueva, and Silva, 1936)	11.2	1.25	46
Paoay, Ilocos Norte (Santos, Villanueva, and Silva, 1936)	12.0	1.40	48
Pototan, Iloilo (Santos, Villanueva, and Silva, 1936)	12.0	1.08	37
Calabanga, Camarines Sur (Present study)	9.9	1.35	56
American—Medium work (Atwater, cited by Lusk, 1928)	15.0	1.79	49
German—Medium work (Rubner, cited by Lusk, 1928)	18.0	1.81	41
Japanese (Grey, 1928)	13.2	1.78	53
Javanese (Langworthy, 1911)	11.6		
Chinese (Langworthy, 1911)	11.0		
Standard (Santos and Adriano, 1928)	13.1		

TABLE 5

Distribution of proteins

	PLANT	ANIMAL	RICE
	per cent	*per cent*	*per cent*
Farmers—Los Baños (Roxas and Collado, 1922)	61.0	39.0	55.9
Male Students, U.P. Manila (Concepcion, 1933)	61.3	38.7	
Sta. Catalina, Ilocos Sur (Santos, Villanueva and Silva, 1936)	69.6	30.4	58.1
Paoay, Ilocos Norte (Santos, Villanueva and Silva, 1936)	66.6	33.4	46.7
Pototan, Iloilo (Santos, Villanueva and Silva, 1936)	65.1	34.9	59.1
Calabanga, Camarines Sur (present study) ..	70.0	30.0	63
American (Rose, 1930)	39.1	60.9	29 (cereals)

TABLE 6

Showing percentage distribution of calories

	CEREAL GRAINS	MEAT FISH, EGGS	MILK AND DAIRY PRODUCTS	FRUITS AND VEGETABLES	SWEET AND FATTY FOODS, ETC.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
C. A. Students (Roxas and Collado, 1922)	75.16	13.57	1.28	7.06	2.93
Beriberic families—Cavite & Nueva Ecija (Santos, unpublished)	82	10		5	3
Male Students, U.P. Manila (Concepcion, 1936) ...	61.66	24	1.5	4.23	8.61
Pototan, Iloilo (Santos, Villanueva & Silva, 1936)	90.41	5.94		2.59	1.06
Sta. Catalina, Ilocos Sur (Santos, Villanueva & Silva, 1936)	89.25	5.31		4.19	1.35
Paoay, Ilocos Norte, (Santos, Villanueva & Silva, 1936)	78.15	10.90	0.25	8.78	1.92
Calabanga, Camarines Sur (present study)	79.40	4.33	0.05	13.31	2.92
U. S. Moderate (Rose, 1930)	30	15	13	15	27
Japanese (Grey, 1928)	66	13		15	6
North Chinese (Wu, cited by Concepcion, 1933) ..	72	6.8	0.06	8.7	12.6

THE CHEMICAL AND PHYSICAL COMPOSITION OF THE FINE EJECTA OF MAYON VOLCANO[1]

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WITH TWO TEXT FIGURES

Mayon Volcano in the province of Albay has been the subject of systematic studies for many years. The interesting works of Abella y Casariego (1882, 1885), Coronas (1897), Craig (1917), Smith (1924), Sherman (1929), Pendleton (1934), Selga (1937), and a number of other investigators are proof of the importance of this mountain and its occasional activity. According to the available literature there has been no study made of the chemical and physical composition of the fine ejecta of Mayon Volcano; hence, the present work was undertaken.

MATERIALS AND METHODS

Two weeks after the eruption of Mayon Volcano on June 5, 1938, seven samples were collected in the different towns around its base. They were available only in some remote places where transportation was very difficult. The first six samples were similar in appearance to very finely pulverized rocks; they were gray when dry, and dark brown to almost black when moistened. The texture was similar to that of ordinary soil in that it was composed of very fine and coarse grains which could be detected when felt between the fingers. Samples 1, 4, and 6 were collected in the barrios of Suá, Tinubran, and Anoling, respectively, of the town of Camalig; sample 2, around the rest house; samples 3 and 5 in the barrios of Masarawag and Maninila, respectively, of Guinobatan. The seventh belonged to that class of volcanic ejecta called lava. Unlike the other samples, it was found only around the rest house at an elevation of 2,500 feet above sea level. It had the appearance of puddled and dried fine-textured soil and was resistant to the action of water.

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[1] Experiment Station contribution No. 1287. Read before the Los Baños Biological Club, September 29, 1938.

[2] The present study was undertaken at the suggestion of Dean B. M. Gonzalez of the College of Agriculture at Los Baños. The writer is indebted to the Provincial Governor of Albay, Hon. Manuel Calleja, and to the Agricultural Supervisor of that province Mr. J. C. Ilagan for cooperation extended to him.

The chemical composition was determined in accordance with the technique of Rieser (1931). The method prescribed by Robinson (1922) was used in the determination of the physical composition. Since the seventh sample was a very hard massive material and could not be dispersed in water, the determination of the amounts of the different aggregates was carried on only with the first six samples. In the preparation of the samples for the mechanical analysis, it was found that the fine ejecta consisted only of grains having diameters less than 2 millimeters. The amount of loss on ignition (H_2O) was determined according to the method adapted by the Association of Official Agricultural Chemists (1935).

OBSERVATIONS

While collecting the samples from June 20 to June 24, 1938, it was observed that there was nothing peculiar in the appearance of vegetation from Legaspi to Camalig. There was no noticeable accumulation of ash in these places except in the barrios of Suá, Anoling, Quirangay, and Tinubran of the town of Camalig, all close to the foot of the volcano. The towns of Guinobatan, Ligao, and Tabaco, which evidently received a heavy fall, showed serious damage to the vegetation. Since the ash stuck fast to the surface, leafy plants appeared gray with leaves either bent down or broken by the unusual load. Different plants varied in their ability to stand the ash. Abacá (fig. 1) and papaya (fig. 2), among others, appeared to be particularly sensitive. Coconut, coffee, banana, gabi, and rice on the other hand, appeared unaffected.

The proximity of the towns of Libog and Malilipot to the volcano and the fact that previous eruptions produced a deep gully on the slope facing these towns would lead one to believe that lava, ash, and consequent destruction would center in these areas. Contrary to expectation, however, vegetation in these towns showed neither sign of ash coating nor of injury. This apparent anomaly might be attributed to the location of these places on the windward side of the volcano, to the southeast of the province, where they were fully exposed to the wind coming from the Albay gulf. As a result, vegetation in the towns of Guinobatan and Ligao on the southwest of Mount Mayon and Tabaco on the northeast side of the volcano showed greater apparent injury than in Camalig, Daraga, and Legaspi on the south and southeast side, and Malilipot, Bacacay, and Libog on the east. The other towns which were reached by the ash but not damaged were Libon, Polangui, Oas, Tiwi, and Malinao.

The injury to the foliage caused by the ash from the volcano was at first localized yellowing and then blackening. In more serious cases, the leaves were scorched, with their edges shriveled (figs. 1 and 2). It was also noted in the course of the observation that plants having soft, tender, and hairy leaves suffered more than those with hard, thick, and glossy leaves.

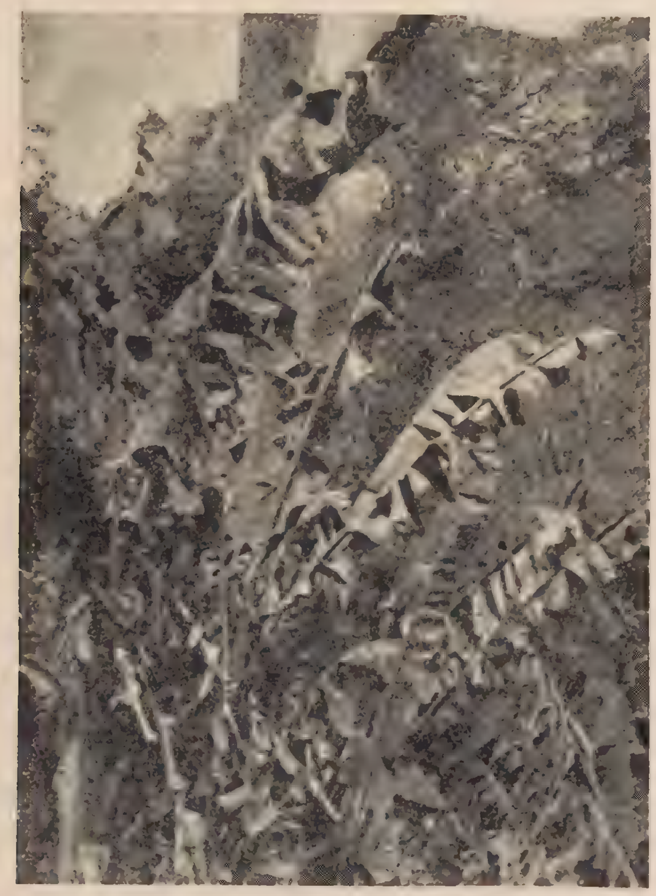

Fig. 1.—Abacá plants showing the scorching effect of the fine ejecta of the recent eruption of Mayon Volcano.

The plants in non-agricultural land above the rest house, 2,500 feet above sea level, were completely defoliated. Destruction was much more serious in areas reached by the flowing molten rocks; the trees were completely burned.

RESULTS AND DISCUSSION

The results of the different determinations are given in tables 1 and 2. All the figures in these tables are averages of duplicate determinations and were calculated from oven-dry samples.

In table 1, the first six samples collected contained all the major constituents of rocks; namely, SiO_2, TiO_2, Fe_2O_3, Mn_3O_4, CaO, MgO, K_2O, Na_2O and P_2O_5. The H_2O was given off as loss on ignition. In addition to these, they contained a minor constituent, SO_3. The constituent that gave the highest average amount was SiO_2; it was 56.36 per cent. This was followed in the descending order by Al_2O_3, CaO, Fe_2O_3, Na_2O, K_2O, MgO, TiO_2, and the loss on ignition. The lowest amount was that of SO_3, being 0.40 per cent. Table 1 further shows that the individual determinations were practically

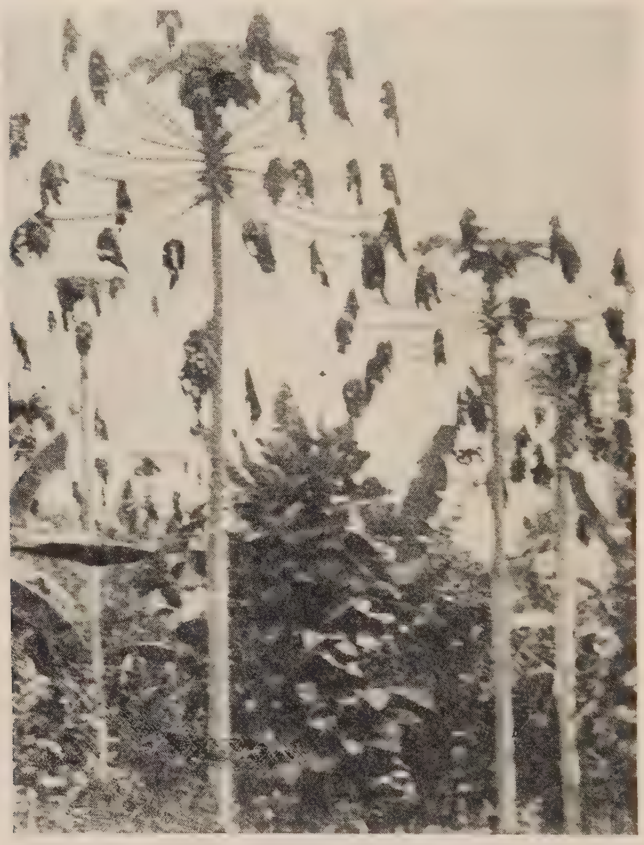

Fig. 2.—Papaya plants showing the killing effect of the fine ejecta of the recent eruption of Mayon Volcano.

the same. Cox (1911) found that the fine ejecta of Taal Volcano had a similar tendency in the individual determinations. The data in table 1 do not show anything which could cause injury to abacá (fig. 1) and papaya (fig. 2) in the towns of Guinobatan, Ligao, and Tabaco. As the samples were collected several days after the violent eruptions, it was possible that these data do not show all of the substances present in the ejecta when they fell on the vegetation.

When the chemical composition of the finer ejecta was compared with that of lava, it was evident as shown in table 1a that their constituents were similar both in quality and in quantity (columns 1 and 2). It is also apparent in table 1a that the ash and lava from Mayon Volcano have constituents similar to those from Taal Volcano. Smith (1924) reported that the rocks of Mayon Volcano and Taal Volcano are both andesite. The ejecta studied by the writer were high in SiO_2, Al_2O_3, Mn_3O_4, CaO, and P_2O_5, but low in others. The SO_3 content in columns 1 and 2 were about twenty seven times less than those in columns 3 and 4. The amount of P_2O_5 was about thirteen times as much. Cox (1911) found that the alkali contents, K_2O and Na_2O, of his samples were completely soluble in water.

The experience of the people of Albay is that the injury to vegetation is only momentary; the affected plants recover after a few months. From an agricultural point of view, it seems that more beneficial effects per unit quantity may be derived from the ejecta of Mayon Volcano than from that of Taal Volcano (table 1b).

Table 2 shows that the volcanic ash consisted of grains up to 2.00 millimeters in diameter. The aggregate whose diameter was the same as that of clay varied from 3.00 to 7.25 per cent; the average was 4.83 per cent. The next fraction which might be classed as silt ranges from 35.03 to 63.19 per cent; the average was 42.26 per cent. The amount of silt was much higher than that of the other fractions. The second highest was the aggregate having an average diameter of from 0.02 to 0.10 millimeter. It had an average of 20.51 per cent. The lowest fraction consisted of grains having a diameter of from 1.00 to 2.00 millimeters. The amounts of the individual constituents were in accord with those of Cox (1911) who made a study of the physical composition of the fine ejecta of Taal Volcano from its eruption in 1911. In general, it may be concluded that the textural grade of the ejecta of Mayon Volcano is similar to that of loam.

Table 2a shows that the samples from Mayon Volcano were richer in finer particles than those from Taal Volcano. The fractions having a diameter of from 0.00 to 0.05 millimeter gave an average sum of 0.71 per cent for Taal Volcano and 47.09 per cent for Mayon Volcano. In the case of the coarser separates, it was just the reverse. From these findings, it may be stated that when exposed to the same conditions the ash from Mayon Volcano may be expected to be more susceptible to chemical weathering than that from Taal.

SUMMARY AND CONCLUSIONS

1. The fine ejecta of Mayon Volcano collected two weeks after its eruption on June 5, 1938, contained all the chief constituents of rocks; namely, SiO_2, TiO_2, Al_2O_3, Fe_2O_3, Mn_3O_4, CaO, MgO, K_2O, Na_2O, P_2O_5, and H_2O. It also contained SO_3.

2. The chemical constituents of the lava were similar to those of the fine ejectas both in quality and quantity. The ejecta did not show substances which are injurious to plants.

3. The chemical composition of the fine ejecta and the lava was comparable to that of the fine ejecta of Taal Volcano which was collected and analyzed by Cox in 1911.

4. The fine ejecta of Mayon Volcano contained a higher amount of finer particles than that of Taal Volcano and in general its textural grade was similar to loam.

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TABLE 1

Chemical composition of the fine ejecta of Mayon Volcano

SAMPLE NO.	1	2	3	4	5	6	AVERAGE
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
SiO_2	56.05	56.42	56.50	56.56	56.33	56.30	56.36
TiO_2	0.75	0.81	0.84	0.78	0.71	0.76	0.78
Al_2O_3	19.13	19.87	19.25	19.05	19.65	19.27	19.37
Fe_2O_3	8.35	8.12	8.35	8.25	8.63	8.90	8.33
Mn_3O_4	0.40	0.46	0.42	0.50	0.43	0.41	0.44
CaO	8.93	8.50	8.32	8.63	8.40	8.20	8.50
MgO	0.90	1.02	1.31	1.31	1.21	1.00	1.13
K_2O	1.14	1.30	1.12	1.27	1.00	1.12	1.16
Na_2O	2.40	2.09	2.00	1.98	2.06	2.16	2.12
SO_3	0.45	0.36	0.40	0.42	0.38	0.40	0.40
P_2O_5	0.50	0.50	0.59	0.67	0.54	0.54	0.56
Loss on ignition	0.87	0.68	0.52	0.85	1.01	0.36	0.72
Total	99.87	100.13	99.62	100.27	100.35	99.42	99.87

TABLE 1a

Comparison of the chemical composition of the ejecta of Mayon Volcano and Taal Volcano

CONSTITUENTS	MAYON VOLCANO		TAAL VOLCANO	
	Ash *a*	Lava *b*	Ash *c*	Ash *d*
	per cent	*per cent*	*per cent*	*per cent*
SiO_2	56.36	56.00	50.79	50.94
TiO_2	0.78	0.79	1.33	1.30
Al_2O_3	19.37	19.25	16.17	15.22
Fe_2O_3	8.33[e]	7.80[e]	3.20	3.70
FeO	—	—	5.77	5.76
Mn_3O_4	0.44	0.48	trace	trace
CaO	8.50	8.60	7.70	7.13
MgO	1.13	1.12	2.87	3.08
K_2O	1.16	1.02	—	—
Na_2O	2.12	2.12	—	—
SO_3	0.40	0.44	10.53	11.54
S	—	—	0.50	0.42
P_2O_5	0.56	0.60	0.06	0.03
Loss on ignition	0.72	0.20	1.31	1.36

[a] Average of six samples.

[b] Lava collected around the rest house.

[c] Finest ash from upper southern slope of Taal (Analyzed by Cox (1911).

[d] Ejecta from area where mud was 1 cm. deep (Analyzed by Cox (1911).

[e] Includes FeO.

TABLE 2

Mechanical composition of the fine ejecta of Mayon Volcano

SAMPLE NO.	1	2	3	4	5	6	AVERAGE
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Clay (0.00–0.002 mm)	7.75	3.35	3.25	7.00	4.60	3.00	4.83
Silt (0.002–0.02 mm)	63.19	36.04	37.25	47.01	35.03	35.06	42.26
Very fine sand (0.02–0.1 mm)	26.79	12.83	10.84	27.60	22.76	22.26	20.51
Fine sand (0.1–0.25 mm)	1.60	7.84	9.14	11.03	17.18	19.07	10.98
Medium sand (0.25–0.5 mm)	0.16	10.63	9.85	3.06	18.18	18.20	10.01
Coarse sand (0.5–1.0 mm)	0.16	19.72	19.30	1.63	1.94	1.76	7.42
Fine gravel (1.0–2.0 mm)	0.15	9.69	10.37	2.76	0.20	0.36	3.51
Total	99.80	100.10	100.00	100.09	99.89	99.71	99.52

TABLE 2a

Comparison of the physical composition of the fine ejecta of Mayon Volcano and Taal Volcano

VOLCANO	MATTER	MOISTURE SOLUBLE	SIZE OF GRAINS IN MILLIMETERS						
			» 0.50	0.50 0.25	0.25- 0.10	0.10- 0.05	0.05 -0.01	0.01—0.002	« 0.002
Taal[a]	5.03	5.07	27.10	7.54	27.42	27.26	0.15	0.47	0.00
	6.35	6.21	7.15	5.75	48.51	24.72	0.38	0.41	0.00
Average	5.69	5.64	17.13	6.65	37.97	25.99	0.27	0.44	0.00
Mayon	—	—	10.93	10.01	10.98	20.51	42.26		4.83

[a] Taal Volcano samples were collected and analyzed by Cox (1911).

PHYSIOLOGICAL STUDIES ON POULTRY: III. THE DRESSING PERCENTAGES OF MALE AND FEMALE LOS BAÑOS CANTONESE FOWLS [1]

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In a preliminary study, Fronda (1933) found that the male Los Baños Cantonese fowl dressed 88.88 per cent and the female, 90.67. In the native fowls, the male dressed 89.80 per cent and the female, 91.25. In both breeds of fowls, the females dressed slightly higher than the males. As these figures were based upon data gathered from time to time from fowls of different ages, different physical condition, and among the females, different stages of molting, the present study was conducted in order to have a more definite knowledge of this character in the Los Baños Cantonese fowl. Apparently few studies have been made along this line in other breeds of fowls. For this reason, the data contained in this report should be of value.

Stoneburn (1906) found that cocks dressed 92.2 per cent; hens, 92.3; cockerels, 89.0; and pullets, 91.9. The dressing percentage of milk-fed poultry, however, is much lower than these figures. According to Lee (1911), as cited by Fronda (1933), milk-fed hens dressed only 85.6 per cent, and roosters, 85.3. Lee also reported that the loss of weight or shrinkage in dressing (without drawing) for the different classes of fattened poultry varied as follows: hens, 13.4 to 14.9 per cent, or an average of 14.7 per cent; springs, 9.0 to 14.5, or an average of 12.1 per cent; and broilers, 14.0 to 14.7, or an average of 14.3 per cent.

The comparative percentages of edible meat, in uncooked condition, of the different classes of live stock reported by Vernon (1924) follow: poultry, 62.24 per cent; pork, 75.75; beef, 60.01; and lamb, 53.80 per cent.

The object of the present study was to compare the dressing percentages and the amounts of edible portions at different ages of male and female Los Baños Cantonese fowls. The study was begun in April, 1932, and closed in November, 1934.

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[1] Experiment Station contribution No. 1288.

PLAN OF THE STUDY

The chickens used in this study were raised under normal conditions. Studies were made at five different ages: namely, at hatch, at two months, at four, at six, and at eight. In each set of observations, twenty birds were used, ten males and ten females. The mean weights of these birds at the time of observation were as follows:

AGE	MALES	FEMALES
	grams	*grams*
At hatch	29.1 ± 0.612	30.9 ± 0.628
Two months	331.3 ± 2.550	340.8 ± 3.015
Four "	768.9 ± 7.676	797.9 ± 8.277
Six "	1064.0 ± 40.038	1096.9 ± 40.885
Eight "	1148.5 ± 42.541	1339.0 ± 39.903

Bleeding. Before the birds were bled, feed was withheld from them for at least twelve hours, during which period they were supplied with plenty of water. The initial or live weight of the birds was recorded before they were bled. In bleeding, the method suggested by Pennington and Betts (1910) was followed. The bird was hung up-side-down on a shackle. Grasping the skull with the left hand so that the thumb and the forefinger were placed just back of the ear, and holding up the lower beak and tongue with the middle or third finger, the knife was inserted into the right side of the roof of the chicken's mouth until the sharp point was felt against the thumb or finger. The knife blade was then tipped against the joint of the neck, thereby cutting the veins.

Weight of blood. The weight of the blood was obtained by subtracting the weight of the bird after bleeding from the initial or live weight of the bird.

Weight of feathers. The birds were dry-picked immediately after bleeding. The weight of the feathers was found by subtracting the weight of the fowl after picking from its weight after bleeding.

RESULTS AND DISCUSSION

Dressing percentage. In this study, the ratio of the dressed fowl, undrawn, to its live weight was considered as its dressing percentage. It may be seen in table 1 that there is no consistent difference between the dressing percentages of male and female Los Baños Cantonese fowls. The only significant difference observed was at the age of two months when the females dressed 1.29 ± 0.276

per cent higher than the males. At the other ages studied, the differences were not significant.

Amount of blood. In table 2, it may be seen that no consistent differences were found between the loss of weight incurred in bleeding male and female fowls. This lack of consistency is apparent as the amount of blood that may be withdrawn in dressing is due, to a large extent, to the effectiveness of the technique used in bleeding. The very low weight of blood drawn from the eight-month-old cockerels, only 39.4 ± 0.130 grams or 3.43 per cent of the live weight, is apparently due to faulty bleeding. At this same age, the females lost 55.1 ± 0.651 grams of blood or 4.11 per cent of the live weight.

On the basis of live weight, the baby chicks lost the most blood; 5.84 per cent in the male and 5.50 per cent in the female. While the weight of blood drawn increased as the birds became older, the proportion of this loss to the live weight remained more or less constant.

Weight of the feathers. It is shown in table 3 that except at hatch and at the age of eight months, the males seem to have more feathers than the females. The differences were, however, significant only at the age of two months, 5.4 ± 0.674 grams, and at four, 6.1 ± 0.756 grams. The differences between the feathering of male and female chickens become more apparent when the figures are based upon the live weight of the birds. In all cases, except at the age of eight months, the percentages were higher in the males than in the females. At eight months of age, the percentage of the feathers of the male, 6.94 per cent, was essentially the same as that of the female, 7.04 per cent.

Percentage of edible portion. The term edible portion of the bird as used in this paper includes the meat and the giblets which consist of liver, heart, and gizzard. The edible portion was determined by subtracting from the dressed weight the weights of the head, neck, shanks, bones, and the viscera, excluding only the gizzard, liver, and heart. To the housewife, the ratio of the edible portion to the live weight of the bird is of value.

It may be seen in table 4 that the females consistently had a higher percentage of edible portion than the males, although the differences were not significant except at the age of two months when the females had 4.22 ± 0.1.149 per cent more edible portion than the males. It is apparent that the percentage of edible portion was higher among the mature fowls than among the rapidly growing individuals.

Expressed in actual weights, the amounts of edible portion that may be obtained from four, six, and eight month old Los Baños Cantonese fowls follow:

AGE	MALE		FEMALE	
	Live weight	Edible portion	Live weight	Edible portion
	grams	*grams*	*grams*	*grams*
Four months	768.9	454.0	797.9	474.0
Six "	1064.0	682.0	1096.9	710.0
Eight "	1148.5	733.0	1339.0	858.0

Of these figures, approximately 6.4 per cent in both males and females constitute the giblets. The remainder of the edible portion is the meat alone.

SUMMARY AND CONCLUSIONS

The results of observations on the dressing percentage of male and female Los Baños Cantoness fowls made at different ages are reported in this paper. These results may be summarized as follows:

1. No consistent differences were observed between the dressing percentage of male and female fowls in all the ages studied.

2. No consistent differences were observed between the loss of weight incurred in bleeding male and female fowls.

3. There are indications that the males have more feathers than the females.

4. The female fowl had a tendency to have more edible portion than the male.

5. It is apparent that the percentage of edible portion was higher among fowls six or eight months old than among the younger ones.

6. An eight-month old cockerel weighing 1148.5 grams dressed 89.38 ± 0.338 per cent and produced 733.0 grams of edible portion.

7. An eight-month old pullet weighing 1339.0 grams dressed 88.66 ± 0.294 per cent and produced 858.0 grams of edible portion.

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TABLE 1

Dressing percentage of male and female Los Baños Cantonese fowls at different ages

AGE	MALE	FEMALE	DIFFERENCE
	per cent	*per cent*	*per cent*
At hatch	90.30 ± 0.314	90.63 ± 0.293	0.33 ± 0.429
Two months	88.30 ± 0.183	89.59 ± 0.207	1.29 ± 0.276
Four "	87.34 ± 0.424	87.71 ± 0.174	0.37 ± 0.458
Six "	88.00 ± 0.161	88.28 ± 0.312	0.28 ± 0.351
Eight "	89.38 ± 0.338	88.66 ± 0.294	0.72 ± 0.448

TABLE 2

Amount of blood drawn from male and female Los Baños Cantonese fowls at different ages

AGE	MALE		FEMALE	
	Weight	Proportion to live weight	Weight	Proportion to live weight
	grams	*per cent*	*grams*	*per cent*
At hatch	1.7 ± 0.064	5.84	1.7 ± 0.090	5.50
Two months	13.0 ± 0.200	3.92	14.9 ± 0.095	4.37
Four "	36.5 ± 0.667	4.74	36.1 ± 0.645	4.52
Six "	51.4 ± 0.473	4.83	51.3 ± 1.375	4.68
Eight "	39.4 ± 1.130	3.43	55.1 ± 0.651	4.11

TABLE 3

Weight of feathers of male and female Los Baños Cantonese fowls at different ages

AGE	MALE		FEMALE	
	Weight	Proportion to live weight	Weight	Proportion to live weight
	grams	*per cent*	*grams*	*per cent*
At hatch	1.1 ± 0.010	3.78	1.1 ± 0.012	3.56
Two months	25.7 ± 0.261	7.76	20.3 ± 0.622	5.96
Four "	67.3 ± 0.343	8.75	61.2 ± 0.674	7.67
Six "	75.7 ± 0.472	7.11	73.8 ± 0.515	6.73
Eight "	79.7 ± 0.894	6.94	94.3 ± 1.401	7.04

TABLE 4

Percentage of edible portion in male and female Los Baños Cantonese fowls at different ages

AGE	MALE	FEMALE	DIFFERENCE
	per cent	*per cent*	*per cent*
At hatch [a]	—	—	—
Two months	61.44 ± 1.092	65.66 ± 0.359	4.22 ± 1.149
Four "	58.89 ± 0.730	59.17 ± 0.595	0.28 ± 0.941
Six "	63.07 ± 0.544	64.80 ± 0.675	1.73 ± 0.866
Eight "	63.08 ± 1.670	64.23 ± 0.675	1.15 ± 1.801

[a] Not determined.

COLLEGE AND ALUMNI NOTES

The thirteenth initiation program of the Society for the Advancement of Research (honorary and scientific) was held in the College of Agriculture auditorium on Thursday evening, December 8, 1938. The following people who were elected on November 17, 1938, were initiated:

Associate Members

Luis Aguilar
Ian Khambanonda
Victor Luis
Isidro Macaspac

Active Members

José M. Capinpin, M.S., A.M., Ph.D.
Pablo I. de Jesus, M.D., Dr. P.H.
Hilario Lara, M.D, C.P.H., Dr. P.H.
Domingo B. Paguirigan, M.S.
Nicanor G. Teodoro, M.S., Ph.D.

Dr. Antonio G. Sison, Dean of the College of Medicine of the University of the Philippines was the guest of honor. The guest speaker was introduced by Dr. B. M. Gonzalez, Dean of the College of Agriculture and an active member of the SAR. The title of Doctor Sison's address was "What science has done for humanity."

The following members of the faculty of the College of Agriculture were delegates to the Conference on Higher Education held under the auspices of the University of the Philippines in Manila, December 12 to 17 in connection with the thirtieth anniversary celebration of the institution:

1. Prof. Dionisio I. Aquino
2. Prof. Ricardo Buhay
3. Prof. Teodosio Buenaventura
4. Prof. Alejandro B. Catambay
5. Prof. Josefa D. Diaz
6. Prof. Rafael B. Espino
7. Prof. Elvie B. Fraser
8. Prof. Francisco M. Fronda
9. Dean Bienvenido M. Gonzalez
10. Prof. Leon G. Gonzalez
11. Prof. Antonio I. de Leon
12. Prof. Miguel Manresa
13. Prof. Gerardo O. Ocfemia
14. Prof. Harriett L. Richards
15. Prof. Manuel A. Roa
16. Prof. Francisco M. Sacay
17. Prof. Francisco O. Santos
18. Prof. Leopoldo B. Uichanco
19. Prof. José E. Velmonte
20. Prof. Valente Villegas

At the plenary session of the Conference held in the evening of December 15, Dean B. M. Gonzalez read a paper entitled "Teaching and research in the University."

On December 3, 1938, Dean B. M. Gonzalez was speaker at a convocation in the College of Commerce of the Ateneo de Manila. He discussed the economic effects of Philippine independence.

Dr. Edward Charles Elliott, President of Purdue University, who has been engaged as one of the advisers in connection with the reorganization of the University of the Philippines, visited the College on Wednesday, December 7, 1938. He conferred with Dean Gonzalez and visited the different departments.

On November 23, 1938, Mr. Toribio Mercado of the Department of Agronomy was admitted as a regular member of the Chartered Institute of American Inventors, Washington, D. C. for devising a cane-juice squeezer and a cassava grater.

TEACHING AND RESEARCH IN THE UNIVERSITY [1]

Much has been written on research in education. Colleges of education and school systems in the United States have been unusually busy of late years in attempting to determine the relative value of various educational tools or methods. It is not the object of this paper to dwell on this type of investigations, but rather to inquire into the influence of research activity in the teacher's subject matter on the effectiveness of imparting information to students.

It is generally recognized that education consists of three phases: the imparting of knowledge, the preservation of knowledge, and the acquisition of knowledge. The order in which I enumerate these does not seem logical, for one must first acquire information before he may preserve or impart it, yet this is precisely the order of importance in which they are held in most school systems. Since however, there is already an accumulation of knowledge and experience that should be put to use, and the acquisition of new knowledge is inherently slow, it is only fair to admit that the sequence followed has the virtue of praticability.

Any teacher or student will readily admit that elementary instruction is necessarily definite, authoritative, and even dogmatic, but as progress is made in the acquisition of knowledge, the mind begins to wander, points of view rapidly multiply, and eventually the advancing student, as he develops his personality, begins to question and to feel that almost anyone can justify his opinion provided his point of view is sufficiently circumscribed. It is at this stage that the teacher actively engaged in research has the advantage over one who is not. He is constantly obliged to use his fundamental information and in so doing he perceives the limitations and the variable expressions of its implications. He is ever put up to evaluating this basic knowledge in the interpretation of a thought or a theory he is seeking to apply at the moment. One not engaged in research is led to accept almost any information that comes his way as gospel truth, he has little power of discernment, his outlook becomes grooved to a

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[1] Paper read December 15, 1938, at the Conference on Higher Education on the occasion of the Thirtieth Anniversary of the University of the Philippines. General contribution from the College of Agriculture No. 671.

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narrow path; he is prone to generalizations on the most meager observations, becomes authoritative and even autocratic in his expressions, and instinctively curbs any tendency among his brilliant students, essaying at independence of thought, to wander too far into territory over which his footing is a little insecure. One readily recognizes and laments the consequences of this type of teaching. It is one that should prevail in the lower schools, where minds are immature and where the knowledge dealt with is already so stable as to have stood the test of time and common observation. But where the knowledge is formative or being currently applied, it cannot be treated dogmatically, as attendant conditions are never the same in details which stand vividly at the moment. The teacher-researcher finds his best place in the college and university level, where in the words of President Hutchins of the University of Chicago, a student ceases to be taught and begins to learn.

I make a plea to fellow administrators to recognize this valuable type of instruction as one that gives life to education, aside from its intrinsic merit in advancing the frontiers of knowledge. Teachers with natural ability as researchers should be appreciated and encouraged as worthy leaders capable of independent thinking, and invaluable in the field of collegiate and university education.

Not all good teachers are born researchers, but there should be enough of these on any faculty so that their progressive spirit will have a decided impress on the atmosphere of the institution.

It should be understood, however, that results in research follow no time schedule in their arrival. Sometimes they come in rapid succession, but more often they demand close attention and arduous labor before they can be won. Frequently they happen as in the proverbial example among plants, quick work and superficial effort produce a squash, while hard labor requiring a long time may produce an oak. Again, time to devote to research is necessary, for after all there are only twenty-four hours in a day, and nature demands their fair apportionment into work, recreation, and rest. An instructor overloaded with teaching and administrative duties is neither mentally disposed nor physically conditioned to perform research work. A clear intellect borne out of a certain amount of leisure is prerequisite to research activity. It is the fine distinction between laziness and productive leisure that a vigilant executive is continually called upon to discern that often induces an unsympathetic attitude towards research. Succinctly, the demands on the part of an executive are: (1) ability to recognize the function of research in education, (2) a sporting attitude towards possible failure of expected results, whether justified or otherwise, and (3) patience and confidence in, and understanding of human nature.

Education, in any case, will have to be progressive if it is to maintain its proper position in the scheme of human activities, and the bounds of knowledge must forever be extended to meet the varying and expanding needs of humanity. If the lower schools have their work cut out for them and are unprepared for research, and colleges and universities follow the routine of the lower schools in simply imparting information long known, then there is need of developing a still higher level of educational institution that will fill in the need for extending the bounds of human knowledge. This work cannot be relegated to industrial research institutions, their point of view being utilitarian, their outlook and field of endeavor are necessarily restricted by their economic interests.

Are our colleges and universities disposed then to pass on to others this task that is inherently theirs?

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THE COLLEGE OF AGRICULTURE STUDENTS: THEIR CHARACTERISTICS, ELIMINATION AND SCHOLARSHIP[1]

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In the field of higher education efforts are being directed toward the study of the characteristics of the students, the extent and causes of elimination, and the nature of scholarship. It is now regarded necessary for an instructor to be familiar not only with his subject-matter and methods, but also with his students who are the subject of instruction. A proper understanding of students' background, interests, length of stay in college, elimination, and scholarship will enable school administrators and the teaching staff to make proper adjustments in the curriculum, in the content of courses, and in the methods of instruction.

Review of literature

Although several studies have been conducted on the characteristics, persistence, elimination, and scholarship of students in secondary schools, very few extensive investigations have been made in the field of collegiate education. This is especially true in the Philippines.

In the College of Agriculture of the University of the Philippines, the first investigation along this line was conducted by Sacay (1936), who made a study of several factors that may be used in predicting the scholastic success of freshmen. He determined the relationship to scholastic success of mental ability as measured by the Philippine Mental Ability Test prepared by the Bureau of Education, of performance in the Bureau of Education achievement tests in algebra, geometry, physics, English IV, biology and general science, and of grades obtained in the high school in algebra, geometry, physics, English IV, economics, general history, biology, and general science. He found that scores in the Philippine Mental Ability Test and those in the achievement tests in algebra, physics, and geometry had very close relationship to freshman success.

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[1] Experiment Station contribution No. 1291. In this study, portion of the data pertaining to elimination and scholarship formed part of a special problem conducted by the junior author as one of the requirements for graduation with the degree of Certificate in Agricultural Education from the College of Agriculture in March, 1938.

Sacay (1937) also enumerated other problems relating to student population that should be the subject of study in the College of Agriculture.

Uichanco (1937) included in his historical sketch of the College of Agriculture, data on the yearly enrollment as well as the place of origin of students. His figures showed that the highest enrollment of 881 occurred in the school year 1928-29, and that Pangasinan supplied 11.3 per cent while Laguna, 11.0 per cent of the student population from the foundation of the College in 1909 up to the first semester of 1936.

In the United States, Good (1929) cited the investigation of Potthoff and Moon (1926) who found that in the University of Chicago, two-fifths of the 1919 freshman class were able to graduate. Tallman (1927) estimated that in the University of Iowa, about 57 per cent of the freshmen in 1920 would eventually complete four years of college work in that institution. He also found that the highest percentage of graduation in that university was among the group that completed high school at the age of eighteen.

West (1928) made a study of student mortality in a well known state university. He found that nearly one-third of an entering freshman class withdrew before the end of the first year. It was estimated that not more than 50 per cent of any freshman class could be expected to graduate within five years.[2]

Bennett (1933) cites an unpublished study of John A. Anderson of the Pasadena Junior College, which showed that the 1932 enrollments in eighty higher institutions in the Pacific Coast area were distributed by college years as follows: freshman, 35.4 per cent; sophomore, 26.3 per cent; junior, 13.3 per cent; senior, 13.8 per cent; special, 3.5 per cent; and graduate, 7.7 per cent.

Objects of the present study

The principal objects of the present study were to determine: (*a*) certain characteristics of the student population in the College of Agriculture of the University of the Philippines, such as age, occupational background, economic status, and vocational choice; (*b*) the persistence and elimination of students; and (*c*) the students' scholarship, such as grades obtained and delinquencies received by those who succeeded in obtaining a degree.

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[2] *Cited by* Bennett, M. E. 1933.

MATERIALS AND METHODS

In the study on student characteristics, occupational background, family income and vocational choice, the freshmen who entered the College of Agriculture, University of the Philippines in 1936 and 1937 were used. These students numbered 260. The necessary information was obtained from these students with the aid of a questionnaire.

The part pertaining to elimination, persistence, and scholarship was based on the records of students who entered the College of Agriculture from June, 1920, to June, 1929, a period of ten years. The records of these students, who numbered 2,275, were secured from the office of the Secretary of the College. For each student, the following information was secured and entered on a mimeographed form: date and place of birth, home address, previous schools attended, highest grade completed, whether he was regular or irregular student at time of entrance, date he entered college, date he left, grades obtained in different college courses, number of *4's* and *5's* and delinquencies received, and date of obtaining a degree. On the same form were made the necessary computations.

RESULTS AND DISCUSSION

The results of this study are presented in tables 1 to 19.

Enrollment and entrance qualifications

The enrollment of new students in the College of Agriculture from 1909 to 1929 is shown in table 1. Starting with 53 in 1909, the number reached the peak in 1928, when 353 new students enrolled.

Students who registered in the College may be divided into two types: (1) non-high school graduates who enrolled in the six-year curriculum leading to the degree of Bachelor of Agriculture and (2) high school graduates who pursued the four-year course leading to the degree of Bachelor of Science in Agriculture or the five-year course leading to the degree of Bachelor of Science in Sugar Technology. The first group included students who finished the intermediate academic or the intermediate farming curricula. Some of these graduates attended academic, agricultural, trade or other types of high schools before coming to the College. Some of the high school graduates included in the second group also attended other schools or colleges before enrolling in the College of Agriculture.

Beginning June, 1929, no new students were admitted unless they possessed high school certificates of graduation. In that year the University Rural High School was opened; it handled the preparation for college of those without a high school diploma. Soon thereafter, the Bachelor of Agriculture curriculum was withdrawn.

The decrease in enrollment of new students from 1928 to 1934 (tables 1 and 2) was the result of several factors, the two most important ones being the non-admittance of new students without high school diploma, and the economic depression. In 1935, however, the enrollment started to increase.

Tables 1 and 2 further show that there were very few agricultural high school graduates in the first two decades following the establishment of the College. From 1926 to 1934, the yearly enrollment of the agricultural school graduates ranged from 19 to 28. Since 1935, the number has increased materially. They now comprise about thirty per cent of new students.

Sources of enrollment

The provinces from which the enrollment in the College of Agriculture came are shown in table 3. From June, 1909, to June, 1935, 2,692 intermediate and 1,918 high-school graduates entered the College, or a total of 4,610. Every province in the Philippines is represented by at least two students. The largest number, 509, came from Pangasinan. Laguna followed with 495. From Batangas came 345; Occidental Negros, 215; Rizal, 202; Nueva Ecija, 190; Iloilo, 186; and Bulacan, 179. Only 2 students came from Batanes, 4 from Camarines Norte, and 6 from Surigao.

Inasmuch as certain provinces have a larger population than others, it is to be expected that a larger number will come from provinces with more inhabitants. To determine the provinces that sent the largest number per 100,000 residents in 1935, as estimated by the Bureau of Health, table 3 was prepared. This table shows that Laguna ranks the highest, with 202.5 students for every 100,000 people. The others are: Cavite, 96.2; Zambales, 88.5; Batangas, 81.0; Nueva Vizcaya, 75.3; Pangasinan, 72.3; Isabela, 70.2; and Bulacan, 64.9. The provinces with the smallest representation are: Sulu, 2.7; Surigao, 3.9; Mountain, 4.0; Oriental Negros, 4.8; Cotabato, 5.4; Zamboanga, 6.0; Camarines Norte, 6.2; and Lanao, 6.3.

The relation of proximity to Los Baños to extent of enrollment

To determine the effect of proximity upon the extent of enrollment, the provinces in the Philippines were roughly grouped into districts or zones, as shown in table 4. The table shows that in general, distance from the College adversely affects the enrollment. In the first zone, the average was 91.8 students for every 100,000 persons. There were only 9.7 in the sixth zone. One will notice, however, that certain provinces sent relatively more students to the College than those more closely situated to Los Baños. The adverse effect of distance on enrollment in secondary schools was reported by the Monroe Survey Commission, which found that 43.0 to 58.5 per cent of students in an academic high school came from within a radius of twenty kilometers. The commission concluded that the geographical factor is important in determining attendance.

Sacay (1933) also found that in three rural high schools, from 80 to 98 per cent of the enrollment came from the province where the school was located. In the case of agricultural high schools, the percentage ranged from 25.8 to 93.6.

How students happened to know the College

The students came to know the College through various ways, as shown in table 5. Although students learned of the College in more than one way, only the one which the students thought the most important was considered. Table 5 shows that 25.4 per cent of the 1936 and 1937 freshmen received their information about the College of Agriculture from townsmen and relatives who studied or were studying in the institution. The teachers, especially those in agricultural schools, furnished to a large number of students information about the College. Most of those teachers are College of Agriculture alumni. Publications prepared by the College as well as those by the University have contributed much in bringing the College to the attention of the students. Only 5.0 per cent became acquainted with the College through excursions. Newspaper and magazine articles contributed more, the percentage of students influenced being 7.7.

Age of students at entrance

The age of regular intermediate school graduates[3] who entered the College from 1920 to 1929 is shown in table 6. The age ranged from 12 to 31 years. One will readily notice the fact that students have constantly become younger. Whereas the average age in 1920 was 19.2 years, it was only 17.1 in 1928, or a reduction of 2.1 in nine years. It is commonly observed in the high school that students are much younger and smaller now than those in attendance ten years ago.

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[3] A regular intermediate school graduate is one who had not attended a high school before entering the College of Agriculture.

The average age of regular intermediate agriculture graduates when they enrolled in the College was 19.1 years, or 0.8 years higher than that of intermediate academic graduates, which was 18.3 years.

The average age at entrance of regular academic high school graduates[4] who enrolled in the College from 1920 to 1929 ranged from 15 to 33 years. There has been a gradual reduction in age from 1920, when the average was 22.0 years, to 1929, when it was only 21.0 years. The average age of students for the ten-year period was 21.4 years.

The reduction in age has continued, judging from the age of students who entered the College recently. Table 7 shows that the average age of academic high school graduates who entered the College in 1936 and 1937 was 20.3 years, or 0.7 year less than the average age in 1929.

The average age of regular agricultural high school graduates entering the College was 23.0 for the ten-year period. This is 1.6 years greater than that of academic high school graduates.

The difference in age between the academic and agricultural graduates was only 0.6 years among the 1936 and 1937 freshmen (table 7). Table 7 also shows that 22.4 per cent of the new students were 20 years old, while 42.8 per cent were 21 years or older at entrance.

Occupations of parents of students

The occupations of fathers of the 1936 and 1937 freshmen are given in table 8. About one-half of the parents, or 49.4 per cent, were engaged in farming. Another 1.8 per cent were landlords and 1.1 per cent, farm managers. The next important group, the merchants, comprised but 6.3 per cent. Only a few students were sons of parents engaged in the professions, the percentage being as follows: dentists, 0.4 per cent; physicians, 0.7; lawyers, 0.7; teachers and professors, 2.5 per cent. The foregoing figures show that about half of the students that enter the College come from the farming group. In the case of agricultural school graduates who entered the College, 63.8 per cent were children of farmers.

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[4] A regular high school graduate is one who had not attended a college before entering the College of Agriculture.

Estimated family income

In order to determine the economic status of students entering the College of Agriculture, they were asked to make an estimate of the family income. Table 9 shows that 51.1 per cent of the students come from families with incomes below ₱500 a year. This is especially true among agricultural school graduates. Many of these boys entered agricultural schools as self-supporting students, and they came to the College with the idea of working their way through. Table 9 also reveals that only one-fourth of the students came from families earning more than ₱1,250 a year.

Students' choice of agricultural vocations

In order to determine their occupational interests, the 1936 and 1937 freshmen were asked to check not more than two of a large number of vocations in the field of agriculture. They were also permitted to select other vocations not in the list but in which they were interested. Table 10 shows that 16.5 per cent desired to become farm managers; 15.3 per cent, teachers of agriculture; 11.8, agronomists; 9.6, animal husbandmen; 9.2, general farmers; and 7.8 per cent, poultry raisers. There seems to be a close relationship between the students' choice and occupational demand as revealed by employment of alumni of the College.

Tables 10 also shows that 2.2 per cent of the freshmen were undecided; 1.0 per cent wanted to become merchants; 0.2, foresters; and 0.4 per cent would enter military service.

Proportion of students who were able to graduate

The yearly enrollment and the number who graduated are shown in table 11. Of the 1,377 intermediate graduates who entered the College from 1920 to 1928, only 16.9 per cent succeeded in completing the course leading to the degree of Bachelor of Agriculture. The percentage of graduation ranged from as low as 12.8 per cent in 1924 to as high as 21.5 per cent in 1920.

The percentage of graduation among high school graduates was much higher. Of the 898 students, 38.4 per cent succeeded in obtaining the degree of Bachelor of Science in Agriculture. The percentage of graduation ranged from 25.4 per cent in 1924 to 58.3 per cent in 1921. The higher percentage among high school graduates is to be expected, because they are more highly selected individuals. The percentage of graduation among them is almost the same as that found by Potthoff and Moon at the University of Chicago, which was about 40 per cent.

Of the combined intermediate and high school graduates numbering 2,275, only 578, or 25.4 per cent, were able to complete the course.

Ratio of graduation by provinces

The enrollment from each province from 1909 to 1932 and the number that graduated from 1911 to 1936 are given in table 12. From 1909 to 1932, 2,692 intermediate and 1,577 high school graduates, or a total of 4,269, entered the College. Of this total, 1,053 have graduated up to 1936. The largest number of graduates came from Pangasinan, 10.5 per cent; Laguna, 9.5; Batangas, 9.3; Cavite, 5.2; Rizal, 5.2; and Pampanga, 5.0 per cent.

Other things being equal, a large number of graduates will come from a province which sends a large number of students. In order to know the persistence of students from different regions, the ratio of graduates to enrollment was determined, as shown in table 12. The proportion ranged from 0 to 100 per cent. The extremely high or extremely low percentages were found in the case of provinces which sent very few students to the College. Only 21 provinces have had at least 75 students from 1909 to 1932. Among these provinces, the following have a high ratio of graduation: Pampanga, 41.4 per cent; Cagayan, 34.5; Ilocos Norte, 33.8; Cavite, 32.5; Batangas, 30.1; Bulacan, 29.8; Albay, 29.1; Rizal, 28.9; and Nueva Ecija, 27.2 per cent. These high percentages may be attributed to several factors, among which are students' industry, intelligence, and perseverance.

Nature of grades obtained by graduates

The nature of grades obtained by regular intermediate graduates who obtained the Bachelor of Agriculture degree is shown in table 13. In the case of academic students, only 2.9 per cent received grades of *3* or better, without any grades of *4* or *5*. A big majority, 79.6 per cent, received both *4's* and *5's*. Those that received *4's* but not *5's* amounted to 15.3 per cent.

In the case of agricultural school graduates, 75.0 per cent received *4's* and *5's* in their college courses, and only 15.0 per cent did not receive failing grades.

The nature of grades obtained by high school graduates who succeeded in obtaining the degree of Bachelor of Science in Agriculture is shown in table 14. Of the 253 academic high school graduates who obtained the degree, only 4.35 per cent received grades of *3* or better with no *4's* or *5's*. A large majority, 75.9 per cent, received *4's* and *5's*. About 15.4 per cent got *4's* but were able to change them to *3's* upon taking a condition examination. They thus avoided receiving *5's*.

Of the few agricultural school graduates, 6.25 per cent received all passing marks, but 87.5 per cent obtained *4's* and *5's* in some college subjects.

Delinquencies received by graduates

It has been the practice in the College to classify failing students periodically into delinquent, probation, and extreme delinquent. Students falling under the last group are required to leave the College, unless they are relieved from this penalty by the Dean. Table 15 shows that only 18.2 per cent of the B.Agr. graduates did not appear in the delinquency list during their entire stay in the institution. On the other hand, 19.7 per cent fell in each of three classifications at one time or another. The largest group, comprising 28.5 per cent, were both delinquent and on probation.

In the case of the few intermediate agriculture students, 25.0 per cent received no "delinquencies" and 25 per cent received delinquencies, probations, and extreme delinquencies.

Of the academic high school graduates who succeeded in obtaining the B.S.A. degree, 23.3 per cent did not receive delinquencies during their entire stay, and only 12.6 per cent were delinquent, on probation and extreme delinquent. The largest group, comprising 30 per cent, were delinquent only.

In the case of the agricultural high school graduates, 28.1 per cent did not receive any delinquency, but 15.6 per cent fell into all the three classifications. A large number, 37.5 per cent, were delinquent (table 16).

Relation of age to success in obtaining a college degree

There appears to be a negative correlation between age and success in getting the B.Agr. degree, as may be seen in table 17. In the case of students whose age was 15 years or less at the time of entrance, the percentage of graduation was 29.6 or better. The average for this group was 35.4 per cent. For students whose age ranged from 16 to 22 years, the percentage was from 6.2 to 25.8, or an average of 15.5 per cent. None of those who were 23 years or older graduated. It will also be noted that the average age at entrance of those who succeeded in securing the degree was 16.9 years; that for students that did not graduate was 18.6 years. In a previous study reported by Sacay (1936), a negative coefficient of correlation was also found between age and grades of freshmen.

A negative relationship between age and percentage of graduation was also discovered in the case of academic high school students, as shown in table 18. Among students whose age was 22 years or less, the percentage of graduation was 35.1 or higher, or an average of 40.6 per cent for the whole group. In the case of students whose age was 23 years or more, the percentage of graduation was 34.7 per cent or lower, or an average of 28.7 per cent. None of the students who were 28 years or older at the time of entrance were able to graduate.

The average age at entrance of the group that graduated was 21.0 years; that of students who failed to secure the degree was 21.6 years.

In the case of agricultural high school graduates (table 19) no definite conclusion may be drawn. This is due to the small number of cases.

SUMMARY

1. Agricultural high school graduates now comprise about thirty per cent of the new students entering the College.

2. The provinces that have sent large numbers of students to the College from 1909 to 1935 are: Laguna, 202.5 per 100,000 population; Cavite, 96.2; Zambales, 88.5; Batangas, 81.0; Nueva Vizcaya, 75.3; Pangasinan, 72.3; Isabela, 70.2; and Bulacan, 64.9. Provinces closer to Los Baños have sent to the College relatively more students.

3. The average age of intermediate school graduates who entered the College decreased gradually from 19.7 years in 1921 to 17.1 in 1928.

4. The average age of academic high school graduates who entered the College gradually diminished from 22.2 in 1921 to 21.0 years in 1929. The average age of all types of freshmen in 1936 and 1937 was 20.6 years.

5. About one-half, or 49.4 per cent, of these freshmen were sons of farmers. The sons of merchants comprised 6.3 per cent, and of proprietors, 4.8. Only 4.3 per cent were sons of parents engaged in the professions of law, medicine, dentistry, and teaching.

6. About one-half, or 51.1 per cent, of the 1936 and 1937 freshmen came from families having estimated incomes of ₱500 or less. Only 25.5 per cent were from families with incomes over ₱1,250 a year.

7. The agricultural occupations chosen by the freshmen were those of farm managers, 16.5 per cent; teachers of agriculture, 15.3; agronomists, 11.8; animal husbandmen, 9.6; general farmers, 9.2.

8. Of the 1,377 intermediate graduates who enrolled in the College from 1920 to 1928, 16.9 per cent succeeded in obtaining the Bachelor of Agriculture degree.

9. Of the 898 high school graduates who entered the College from 1920 to 1929, 38.4 per cent graduated. Of the 2,275 intermediate and high school graduates studied, 25.4 per cent were able to obtain a degree.

10. Students from certain provinces were more successful than those from other regions in securing a degree, the percentage being as follows: Pampanga, 41.4; Cagayan, 34.5; Ilocos Norte, 33.8; Cavite, 32.5; Batangas, 30.1; Bulacan, 29.8; Albay, 29.1; Rizal, 28.9; Nueva Ecija, 27.2 per cent.

11. Only 2.9 per cent of the intermediate school graduates (academic) completed the college course without receiving grades of *4's* or *5's*. The percentage for academic high school graduates was 4.35, and for agricultural high school graduates, 6.25 per cent.

12. The percentage of students who succeeded in obtaining a degree without being delinquent, on probation, or extreme delinquent was 18.2 for the academic intermediate and 23.3 for the academic high school graduates.

13. A negative relationship between age of students and percentage of graduation was observed.

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TABLE 1

Entrance qualifications of students who entered the College of Agriculture, from 1909-1929 [a]

YEAR	GRADUATES OF INTERMEDIATE SCHOOLS	GRADUATES OF ACADEMIC HIGH SCHOOLS	GRADUATES OF AGRICULTURAL HIGH SCHOOLS	GRADUATES OF OTHER HIGH SCHOOLS AND UNDERGRADUATES	TOTAL
1909	20	6	—	27	53
1910	25	3	—	23	51
1911	48	7	—	29	84
1912	58	11	—	36	105
1913	90	16	1	41	148
1914	112	9	1	44	166
1915	133	14	—	47	194
1916	125	28	—	47	200
1917	140	31	—	48	219
1918	—	37	—	11	48
1919	114	26	1	61	202
1920	120	41	1	56	218
1921	149	34	2	61	246
1922	104	29	4	38	175
1923	114	39	8	39	200
1924	73	44	7	42	166
1925	80	82	7	44	213
1926	114	77	11	63	265
1927	124	108	28	68	328
1928	109	147	28	67	353
1929	—	168	27	2	197 [b]

[a] Based on the reports of the Secretary.

[b] Since 1929, no new student is admitted unless he is a secondary school graduate.

TABLE 2

Entrance qualifications of students who entered the College, from 1929 to 1937

YEAR	ACADEMIC		AGRICULTURAL		OTHERS		TOTAL	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
1929	168	85.3	27	13.7	2	1.0	197	100.0
1930	152	98.7	[c]	—	2	1.3	154	100.0
1931	109	83.9	19	14.6	2	1.5	130	100.0
1932	142	86.6	21	12.8	1	0.6	164	100.0
1933	102	82.9	20	16.3	1	0.8	123	100.0
1934	55	67.9	25	30.9	1	1.2	81	100.0
1935	92	68.7	41	30.6	1	0.7	134	100.0
1936	91	61.1	55	36.9	3	2.0	149	100.0
1937	125	69.8	49	27.4	5	2.8	179	100.0

[c] Graduates of agricultural and rural high schools were advised to enroll in the University Rural High School in order that when they entered the College, they would be able to complete their entrance deficiencies within one year, as required by University regulations.

TABLE 3

Provinces from which came the enrollment in the College of Agriculture, 1909-1935

PROVINCES	INTERMEDIATE [d]	HIGH SCHOOL [d]	TOTAL [d]	POPULATION IN 1935 [e]	ENROLLMENT PER 100,000 POPULATION
Abra	21	19	40	94,484	42.3
Agusan	2	5	7	65,416	10.7
Albay	74	23	97	410,542	23.6
Antique	19	11	30	178,702	16.8
Bataan	22	12	34	70,380	48.3
Batanes	2	—	2	8,214	24.3
Batangas	274	71	345	426,159	81.0
Bohol	36	25	61	451,303	13.5
Bukidnon	3	8	11	45,271	24.3
Bulacan	103	76	179	275,918	64.9
Cagayan	51	39	90	226,153	39.8
Camarines Norte	2	2	4	64,119	6.2
Camarines Sur	39	15	54	240,384	22.5
Capiz	33	73	106	357,214	29.7
Cavite	120	54	174	180,881	96.2
Cebu	22	57	79	1,064,880	7.4
Cotabato	11	1	12	220,017	5.4
Davao	7	6	13	152,750	8.5
Ilocos Norte	66	84	150	260,954	57.5
Ilocos Sur	47	51	98	252,014	38.9
Iloilo	64	122	186	599,486	31.2
Isabela	26	80	106	151,026	70.2
Laguna	383	112	495	244,464	202.5
Lanao	5	4	9	141,782	6.3
Leyte	42	27	69	815,781	8.5
Manila	46	111	157	353,418	44.4
Marinduque	3	8	11	62,280	17.7
Masbate	5	4	9	92,356	9.7
Mindoro	10	1	11	105,647	10.4
Mountain	6	10	16	397,456	4.0
Nueva Ecija	136	54	190	323,962	58.7
Nueva Vizcaya	9	18	27	35,838	75.3
Occidental Misamis	15	1	16	116,066	13.8
Oriental Misamis	12	11	23	153,573	15.0
Occidental Negros	73	142	215	488,716	44.0
Oriental Negros	8	9	17	352,963	4.8
Palawan	3	4	7	103,816	6.7
Pampanga	65	71	136	292,912	46.4
Pangasinan	365	144	509	703,609	72.3
Rizal	147	55	202	314,458	64.2
Romblon	8	7	15	76,870	19.5
Samar	17	20	37	498,402	7.4
Sorsogon	11	9	20	238,866	8.4
Sulu	5	2	7	258,425	2.7
Surigao	4	2	6	155,458	3.9
Tarlac	54	52	106	210,198	50.4
Tayabas	68	35	103	273,455	37.7
Union	66	42	108	194,223	55.6
Zambales	66	22	88	99,482	88.5
Zamboanga	6	6	12	198,662	6.0

TABLE 3 Cont'd.

Foreign countries:					
China	2	26	28	—	—
Siam	2	50	52	—	—
United States	1	11	12	—	—
Guam, Hawaii, Japan, Java, Portuguese India, Sarawak, Spain, Strait Settlements, Sumatra ...	5	14	19	—	—
Total	2,692	1,918	4,610	—	—

[d] From report of the Secretary of the College of Agriculture.
[e] From report of the Office of Vital Statistics, Bureau of Health.

TABLE 4

The relation between proximity to the College and extent of enrollment

ZONE	PROVINCES	ENROLLMENT PER 100,000 PERSONS	AVERAGE
1	Laguna	202.5	91.8
	Batangas	81.0	
	Cavite	96.2	
	Rizal	64.2	
	Bulacan	64.9	
	Tayabas	37.7	
2	Bataan	48.3	73.3
	Zambales	88.5	
	Pampanga	46.4	
	Tarlac	50.4	
	Nueva Ecija	58.7	
	Nueva Vizcaya	75.3	
	Pangasinan	72.3	
3	La Union	55.6	44.04
	Ilocos Sur	38.9	
	Mountain	4.0	
	Isabela	70.2	
	Abra	42.3	
	Ilocos Norte	57.5	
	Cagayan	39.8	
4	Camarines Norte	6.2	14.8
	Camarines Sur	22.5	
	Marinduque	17.7	
	Albay	23.6	
	Sorsogon	8.4	
	Mindoro	10.4	
5	Romblon	19.5	17.2
	Masbate	9.7	
	Capiz	29.7	
	Antique	16.8	
	Iloilo	31.2	
	Negros Occidental	44.0	
	Negros Oriental	4.8	
	Cebu	7.4	
	Bohol	13.5	
	Leyte	8.5	
	Samar	7.4	
	Palawan	6.7	
	Batanes	24.3	
6	Occidental Misamis	13.8	9.7
	Oriental Misamis	15.0	
	Bukidnon	24.3	
	Lanao	6.3	
	Agusan	10.7	
	Surigao	3.9	
	Davao	8.5	
	Cotabato	5.4	
	Zamboanga	6.0	
	Sulu	2.7	

TABLE 5

How the 1936 and 1937 freshmen happened to learn of the College of Agriculture

SOURCES OF INFORMATION	NUMBER	PER-CENTAGE
From townsmen and relatives who studied or are studying in the College	66	25.4
From teachers in high school	50	19.2
From alumni and friends	45	17.3
From literature requested from or furnished by the College or the University	38	14.6
From newspapers and magazines	20	7.7
Residence near the College	16	6.2
From visiting or making excursions to the campus	13	5.0
From members of the College faculty	12	4.6
Total	260	100.0

TABLE 6

Age of students when they entered the College of Agriculture from 1920 to 1929

YEAR	REGULAR INTERMEDIATE ACADEMIC GRADUATES		REGULAR ACADEMIC HIGH SCHOOL GRADUATES	
	Range	Average age	Range	Average age
1920	14-26	19.2	18-27	22.0
1921	15-31	19.7	17-26	22.2
1922	13-27	18.9	17-27	22.1
1923	12-29	18.8	17-29	21.7
1924	13-26	18.4	18-25	21.6
1925	13-23	17.8	17-27	21.4
1926	13-26	17.7	18-33	21.2
1927	13-24	17.2	17-28	21.5
1928	13-28	17.1	15-26	21.2
1929	—	—	16-29	21.0
Average for regular intermediate academic graduates .		18.3		
Average for regular intermediate agriculture graduates		19.1		
Average for regular academic high school graduates				21.4
Average for regular agricultural high school graduates				23.0

TABLE 7

Ages of 1936 and 1937 freshmen

AGE	ACADEMIC HIGH SCHOOLS	AGRICULTURAL HIGH SCHOOLS	MISCELLANEOUS AND FOREIGN SCHOOLS	TOTAL	PERCENTAGE	CUMULATIVE PERCENTAGE
16	3	—	—	3	1.1	1.1
17	6	2	—	8	2.9	4.0
18	26	13	1	40	14.5	18.5
19	24	16	5	45	16.3	34.8
20	38	19	5	62	22.4	57.2
21	22	15	3	40	14.5	71.7
22	12	8	4	24	8.7	80.4
23	6	10	1	17	6.2	86.6
24	5	4	1	10	3.6	90.2
25	3	4	2	9	3.3	93.5
26	4	3	—	7	2.5	96.0
27	—	3	—	3	1.1	97.1
28	2	—	—	2	.7	97.8
29	3	—	—	3	1.1	98.9
30	1	—	2	3	1.1	100.0
Total	155	97	24	276	100.0	—
Average ..	20.3	20.9	21.7	20.6	—	—

TABLE 8

Occupation of fathers of 1936 and 1937 freshmen

OCCUPATIONS	ACADEMIC GRADUATES	AGRICULTURAL GRADUATES	MISCELLANEOUS AND FOREIGN	TOTAL	PERCENTAGE
Accountant ...	1	—	—	1	.4
Agent, salesman	2	—	—	2	.7
Carpenter	1	1	—	2	.7
Clerk	2	—	—	2	.7
Cook	1	1	—	2	.7
Dentist	1	—	—	1	.4
Doctor	2	—	—	2	.7
Employee	3	—	—	3	1.1
Electrician	1	—	—	1	.4
Editor	1	—	—	1	.4
Farmer, agriculturist	71	60	3	134	49.4
Farm manager.	3	—	—	3	1.1
Fisherman	3	1	—	4	1.5
Government official	—	1	10	11	4.1
Justice of peace	1	—	—	1	.4
Health officer .	1	—	—	1	.4
Laborer	9	4	1	14	5.1
Landlord	5	—	—	5	1.8
Lawyer	2	—	—	2	.7
Lumberman ...	—	—	1	1	.4
Merchant, storekeeper	7	5	5	17	6.3
Minister	1	—	—	1	.4
Paymaster	1	—	—	1	.4
Proprietor	12	1	—	13	4.8
President	—	1	—	1	.4
Photographer .	1	—	—	1	.4
Railroad employee	—	—	1	1	.4
Soldier, officer.	3	2	2	7	2.5
Sailor	—	1	—	1	.4
Superintendent, sugar central	1	—	—	1	.4
Tailor	1	—	—	1	.4
Teacher, professor	—	6	1	7	2.5
Treasurer	2	2	—	4	1.5
Tobacco inspector	1	1	—	2	.7
Dead, no answer	13	7	—	20	7.4
Total	153	94	24	271	100.0

TABLE 9

Estimate of family income made by 1936 and 1937 freshmen

INCOME	ACADEMIC	AGRICULTURAL	OTHERS	TOTAL	PERCENTAGE
pesos					
Below 250	27	38	3	68	26.1
251 - 500	34	31	—	65	25.0
501 - 750	21	8	—	29	11.1
751 - 1,000	12	5	2	19	7.3
1,001 - 1,250	8	2	3	13	5.0
1,251 - 1,500	7	2	—	9	3.5
1,501 - 1,750	1	2	—	3	1.2
1,751 - 2,000	8	2	2	12	4.6
2,001 - 2,500	8	1	—	9	3.5
2,501 - 5,000	13	2	5	20	7.7
5,001 - 7,500	2	—	4	6	2.3
7,501 - 10,000	3	—	2	5	1.9
Over 10,000	1	1	—	2	.8
Total	145	94	21	260	100.0

TABLE 10

Choice of vocations of 1936 and 1937 freshmen

VOCATIONS	ACADEMIC GRADUATES	AGRICULTURAL GRADUATES	MISCELLANEOUS	TOTAL	PERCENTAGE
Agronomist ...	37	20	2	59	11.8
Animal husbandman	24	21	3	48	9.6
Botanist	3	—	—	3	.6
Cattle raiser ..	3	1	1	5	1.0
Chemist	7	7	1	15	3.0
Crop inspector .	9	4	—	13	2.6
Entomologist ..	1	1	1	3	.6
Farmer	27	14	5	46	9.2
Farm engineer .	9	4	3	16	3.2
Farm manager.	56	21	5	82	16.5
Fiber inspector	3	3	1	7	1.4
Fruit grower .	12	4	3	19	3.8
Hog raiser	1	1	2	4	.8
Plant pathologist	2	2	—	4	.8
Poultryman ...	29	7	3	39	7.8
Researcher	—	3	1	4	.8
Silk culture ...	1	—	—	1	.2
Soil analyst ...	1	—	1	2	.4
Sugar technologist	16	6	—	22	4.4
Teacher of agriculture	31	39	6	76	15.3
Tobacco inspector	5	1	—	6	1.2
Vegetable gardener	4	—	1	5	1.0
Undecided	3	7	1	11	2.2
Civil engineer .	1	—	—	1	.2
Forester	1	—	—	1	.2
Merchant	2	—	3	5	1.0
Military	1	1	—	2	.4
Total	289	167	43	499	100.0

TABLE 11

Percentage of freshmen graduated from the College from 1920 to 1929

YEAR	INTERMEDIATE GRADUATES			HIGH SCHOOL GRADUATES			COMBINED INTERMEDIATE & HIGH SCHOOL GRADUATES		
	Number enrolled	Number graduated	Ratio	Number enrolled	Number graduated	Ratio	Number enrolled	Number graduated	Ratio
			per cent			*per cent*			*per cent*
1920	172	37	21.5	43	18	41.9	215	55	25.6
1921	206	38	18.4	36	21	58.3	242	59	24.4
1922	140	26	18.6	32	11	34.4	172	37	21.5
1923	152	25	16.4	47	21	44.6	199	46	23.1
1924	109	14	12.8	55	14	25.4	164	28	17.1
1925	112	23	20.5	95	30	31.6	207	53	25.6
1926	152	26	17.1	100	43	43.0	252	69	27.4
1927	172	23	13.4	133	42	31.5	305	65	21.3
1928	162	21	13.0	178	64	35.9	340	85	25.0
1929	—	—	—	179	81	45.3	179	81	45.2
Total	1,377	233	16.9	898	345	38.4	2,275	578	25.4

TABLE 12

Proportion of graduation by province

PROVINCES	ENROLLMENT, 1909-1932			GRADUATES, 1911-1936		PROPORTION OF 1911-1936 GRADUATES TO 1909-1932 ENROLLMENT
	Intermediate	High School	Total	Total	Percentage	
Abra	21	19	40	13	1.2	32.5
Agusan	2	5	7	0	0	0
Albay	60	19	79	23	2.2	29.1
Antique	19	11	30	5	.5	16.7
Baguio	1	3	4	0	0	0
Bataan	22	11	33	10	.9 +	30.3
Batanes	2	—	2	2	.2	100.0
Batangas	274	52	326	98	9.3	30.1
Bohol	36	19	55	12	1.1	21.8
Bukidnon	3	8	11	0	0	0
Bulacan	103	68	171	51	4.8	29.8
Cagayan	51	36	87	30	2.8	34.5
Camarines Norte	2	2	4	0	0	0
Camarines Sur	39	15	54	7	.7	13.0
Capiz	33	68	101	23	2.2	22.8
Catanduanes	14	1	15	1	.1	6.7
Cavite	120	49	169	55	5.2	32.5
Cebu	22	49	71	22	2.1	31.0
Cotabato	11	1	12	2	.2	16.2
Davao	7	4	11	0	0	0
Ilocos Norte	68	59	127	43	4.1	33.8
Ilocos Sur	47	42	89	15	1.4	16.8
Iloilo	63	112	175	41	3.9	23.4
Isabela	26	65	91	18	1.7	19.8
Laguna	383	88	471	100	9.5	21.2
Lanao	5	2	7	2	.2	28.6
Leyte	42	20	62	12	1.4 +	10.4
Manila	46	92	138	31	2.9	22.5
Marinduque	3	8	11	3	.3	27.3
Masbate	5	3	8	1	.1	12.5
Mindoro	10	1	11	0	0	0
Misamis	27	8	35	4	.4	11.4
Mountain	5	6	11	2	.2	18.2
Nueva Ecija	136	44	180	49	4.7	27.2
Nueva Vizcaya	9	10	19	6	.6	31.6
Occidental Negros	72	119	191	35	3.3	18.3
Oriental Negros	8	8	16	4	.4	25.0
Palawan	3	4	7	3	.3	42.8
Pampanga	65	63	128	53	5.0	41.4
Pangasinan	365	122	487	41	10.5 +	22.8
Rizal	147	43	190	55	5.2	28.9
Romblon	8	3	11	4	.4	36.4
Samar	17	16	33	5	.5	15.2
Sorsogon	11	8	19	4	.4	21.0
Sulu	5	1	6	1	.1	16.7
Surigao	4	1	5	0	0	0
Tarlac	54	40	94	25	2.4	26.6
Tayabas	68	32	100	19	1.8	19.0
Union	66	40	106	17	1.6	16.0
Zambales	66	18	84	16	1.5	19.0
Zamboanga	6	5	11	2	.2	18.2

TABLE 12 (continued)

Foreign countries:						
China, Guam, Japan, Java, Portuguese India, Spain, Strait Settlements, Sumatra	7	17	24	3	.3	12.5
Siam	2	27	29	12	1.1 +	41.4
United States ...	1	10	11	3	.3	27.3
Total	2,692	1,577	4,269	1,053	100.0	24.7

[f] Figures computed by office of the Secretary.

TABLE 13

Nature of grades obtained by graduates of the B.Agr. degree

YEAR	ACADEMIC					AGRICULTURAL				
	No 4's or 5's	4's but no 5's	5's but no 4's	4's and 5's	Total	No 4's or 5's	4's but no 5's	5's but no 4's	4's and 5's	Total
1920	2	4	1	13	20	—	1	—	2	3
1921	1	2	2	17	22	1	1	—	3	5
1922	—	2	—	15	17	—	—	—	3	3
1923	—	3	—	8	11	1	—	—	5	6
1924	1	—	—	4	5	1	—	—	—	1
1925	—	1	—	13	14	—	—	—	—	—
1926	—	5	—	16	21	—	—	—	—	—
1927	—	1	—	14	15	—	—	—	2	2
1928	—	3	—	9	12	—	—	—	—	—
Total	4	21	3	109	137	3	2	—	15	20
Percentage	2.9	15.3	2.2	79.6	100	15.0	10.0	—	75.0	100

TABLE 14

Nature of grades obtained by graduates of the B.S.A. degree

YEAR	ACADEMIC					AGRICULTURAL				
	No 4's or 5's	4's but no 5's	5's but no 4's	4's and 5's	Total	No 4's or 5's	4's but no 5's	5's but no 4's	4's and 5's	Total
1920	2	6	—	4	12	—	—	—	—	—
1921	—	4	2	12	18	—	—	—	2	2
1922	—	1	—	7	8	—	—	—	—	—
1923	1	3	2	9	15	—	1	—	1	2
1924	—	—	—	6	6	1	—	—	1	2
1925	1	5	1	13	20	—	—	—	3	3
1926	2	3	1	21	27	—	—	—	6	6
1927	3	2	—	26	31	1	—	—	6	7
1928	1	7	3	40	51	—	—	—	4	4
1929	1	8	2	54	65	—	1	—	5	6
Total	11	39	11	192	253	2	2	—	28	32
Percentage	4.35	15.4	4.35	75.9	100	6.25	6.25	—	87.5	100

TABLE 15

Delinquencies received by academic and agriculture intermediate graduates who obtained the B. Agr. degree

	ACADEMIC		AGRICULTURAL	
	number	*per cent*	*number*	*per cent*
None	25	18.2	5	25.0
Delinquent	30	21.9	3	15.0
Probation	5	3.7	1	5.0
Extreme	2	1.5	—	—
Delinquent and Probation	39	28.5	2	10.0
Delinquent and Extreme	8	5.8	4	20.0
Probation and Extreme	1	0.7	—	—
Delinquent, Probation, and Extreme	27	19.7	5	25.0
Total	137	100.0	20	100.0

TABLE 16

Delinquencies obtained by academic and agricultural high school graduates who finished the B. S. A. degree

	ACADEMIC		AGRICULTURAL	
	number	*per cent*	*number*	*per cent*
None	59	23.3	9	28.1
Delinquent	78	30.8	12	37.5
Probation	10	4.0	—	—
Extreme	5	2.0	—	—
Delinquent and Probation	30	19.8	5	15.65
Delinquent and Extreme	17	6.7	1	3.1
Probation and Extreme	2	0.8	—	—
Delinquent, Probation, and Extreme	32	12.6	5	15.65
Total	253	100.0	32	100.0

TABLE 17

Relation of age to success in obtaining the B. Agr. degree by regular intermediate academic graduates

AGE IN YEARS	GRADUATED	DID NOT GRADUATE	TOTAL	PROPORTION THAT GRADUATED
				per cent
12	1	—	1	100.0
13	7	7	14	50.0
14	10	17	27	37.0
15	16	38	54	29.6
16	24	69	93	25.8
17	30	99	129	23.2
18	23	124	147	15.6
19	8	110	118	6.8
20	10	78	88	11.4
21	3	45	48	6.2
22	5	36	41	12.2
23	—	17	17	—
24	—	14	14	—
25	—	3	3	—
26	—	3	3	—
27	—	1	1	—
28	—	3	3	—
29	—	1	1	—
30	—	—	—	—
31	—	1	1	—
Total	137	666	803	—
Mean	16.9	18.6	18.2	—

TABLE 18

Relation of age to success in obtaining the B.S.A. degree by regular academic high school graduates

AGE IN YEARS	GRADUATED	DID NOT GRADUATE	TOTAL	PROPORTION THAT GRADUATED
				per cent
15	1	—	1	100.0
16	1	1	2	50.0
17	5	9	14	35.7
18	24	26	50	48.0
19	27	50	77	35.1
20	39	59	98	39.8
21	54	82	136	39.7
22	46	61	107	43.0
23	25	47	72	34.7
24	20	38	58	34.5
25	6	27	33	18.2
26	3	13	16	18.8
27	2	6	8	25.0
28	—	5	5	—
29	—	2	2	—
30	—	—	—	—
31	—	—	—	—
32	—	—	—	—
33	—	1	1	—
Total	253	427	680	—
Mean	21.0	21.6	21.4	—

TABLE 19

Relation of age to success in obtaining the B. S. A. degree by regular agricultural school graduates

AGE IN YEARS	GRADUATED	DID NOT GRADUATE	TOTAL	PROPORTION THAT GRADUATED
				per cent
17	—	1	1	—
18	1	4	5	20.0
19	2	2	4	50.0
20	7	8	15	46.7
21	7	7	14	50.0
22	3	10	13	23.1
23	6	13	19	31.6
24	2	17	19	10.5
25	1	4	5	20.0
26	1	10	11	9.1
27	1	3	4	25.0
28	1	3	4	25.0
29	—	2	2	—
30	—	—	—	—
31	—	1	1	—
32	—	1	1	—
33	—	1	1	—
Total	32	87	119	—
Mean	21.9	23.4	23.0	—

A STUDY OF THE GROWTH HABIT OF RICE PLANTS: II. EFFECT OF SHADING ON CAN GROWN PLANTS[1]

ANACLETO L. APAOAN

WITH FIVE TEXT FIGURES

This is the second of the series of experiments on the growth habit of rice plants grown in cans. The study was undertaken to determine the effect of shading on the weights of unhulled and hulled grains, size (length, breadth, and thickness) of the hulled grains, and volume of grains produced from can grown plants. The paper also reports observations on the number of days required by a spikelet to attain maturity, and determination of the response of plants to shade as shown by time and duration of booting, inflorescence emergence, tillering capacity, length and width of particular leaves, average height of the plants, and length of exposed peduncles.

MATERIALS AND METHODS

Preparation of cans

Sixty gasoline cans were cleaned, dried, and their bottoms outside painted with dehydrated coal tar. When the paint had dried, the cans were filled up to 10 centimeters from their tops with equal volumes of top soil taken from the Agricultural Education grounds. Before being put into the cans, the soil was thoroughly pulverized and mixed to make it as uniform as possible. Each can was filled with water, and its soil content puddled carefully. A week later, two holes, about 3 millimeters in diameter, were bored on one side of each can, one of which was 5 centimeters from the lid and the other 10. These were intended to keep the irrigation-water level constant in the cans and to allow drainage.

Seeding and transplanting

The seeds of Guinangang rice variety obtained from the field plants grown by Juliano (1938) were sown on December 7, 1937, in two cans previously prepared for seedbed. Previous to sowing, the seeds were soaked in water for one day. Uniform seedlings were transplanted to the prepared cans on December 22, 1937, fifteen days after seeding. Five seedlings were placed in each can, one to every corner and another in the middle. Thirty cans were used to grow control plants, and the remaining ones were utilized for the experimental plants. For recording, each can in each culture was labelled as follows: for those in the open (control) — $O\text{-}C_1H_1$, $O\text{-}C_1H_2$, etc.; $S\text{-}C_1H_1$, $S\text{-}C_1H_2$, etc. for the shaded (experimental). O and S represented the cultures; C, the can; and H, the hill. H_1, H_2, H_3, and H_4 represented the plants in the corners; H_5, that in the center.

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[1] Experiment Station contribution No. 1292. Prepared in the Department of Agricultural Botany, under the direction of Dr. José B. Juliano.

Shading

A day after transplanting, the experimental plants were shaded. Ipil-ipil was used as posts, and bamboo as rafters. Double cheese cloth sewn together was spread all over the frame including the sides in such a way that the plants did not receive any direct rays of the sun during any part of the day. Provision was made for the frame to be raised, and additional cheese cloth was added so as to accommodate the growing plants. The experimental plants remained under the shade all the time.

Irrigation

To irrigate the plants, water was taken from a faucet with a rubber hose. It was kept to a depth of two centimeters for twenty-seven days from transplanting and twelve centimeters thereafter in both cultures up to maturity of the grains, when it was withheld completely.

Weeding

Whenever any weed appeared in the cans, it was immediately pulled out.

Tillering

Weekly counts were made of the number of tillers per hill in both the shaded and open cultures. Observation for the appearance of tillers in each culture began two days after transplanting. The first tiller appeared on January 3, 1938, in the open culture, that is, twelve days after transplanting or twenty-seven days after seeding; none were observed among the shaded plants until a day after. The weekly tiller counts were made on 150 hills from both treatments and started on January 4, 1938. Counting of tillers was continued up to booting or for a period of nine weeks.

Booting and emergence of panicle

To record the duration of booting in each culture, the complete emergence of the blade of the flag out of the leaf sheath that sub-tended it was used as the index. The date when the tip of the first flag emerged out of the subtending leaf sheath and when the last flag-blade had completely emerged from among the culms in each hill in every can was recorded. This time interval was considered as the duration of booting for each hill.

The dates when the terminal spikelet of the first panicle and the basal nodal insertion of the rachillae of the last panicle in each hill emerged were carefully recorded. This time interval was considered as the duration of panicle emergence for each hill.

Maturation of spikelets

Determination of the number of days needed by an individual spikelet to mature from the time of anthesis was made. The time of opening of over five hundred spikelets taken at random from each culture was observed during the blooming period. Every flower observed to open was marked with a sharp pen point in India ink. One form of mark was used for each day of observation covering a period of three days. One hundred of these marked spikelets from each culture were harvested 12, 16, 20, 24, and 28 days after anthesis, and each group of grains was placed in separate envelopes and carefully labelled. After the harvested seeds had been dried in the sun for about a week, each hundred-grain sample was soaked overnight in tap water, and germinated in sterilized petri dishes lined with new moistened blotting paper. The number of seeds that germinated were counted daily, and the percentage germination was determined.

Harvesting

Before the plants were harvested the average height of 100 hills taken at random from each culture was recorded. This represented the middle reading of the vertical distance between the tallest and lowest panicle in each hill, measuring from the base of each hill to the first node of the axes of the panicles (Juliano, 1938). The lengths of 100 panicles taken at random from 150 hills in each culture were also measured. This was the distance between the nodal insertion of the basal rachillae of the panicle and the tip of the terminal grain of the same panicle. The length and width of the three last leaves of 100 plants taken at random from each treatment were also measured. The length represented the distance between the blade joint and the tip of the blade, while the width was measured midway between these two points.

Inasmuch as the panicles were to be studied individually, they were then harvested separately and placed in separate paper bags and labelled. The unfilled and filled grains were counted from 100 sample panicles gathered at random from 40 hills in each culture. The missing grains were easily detected because of their persistent pedicels. These were later on counted as filled grains because unfilled ones seldom shatter. The panicles obtained from 100 hills of each culture were threshed separately by hand, mixed together, and the cleaned seeds placed in a single bag. Two separate hundred-grain samples were taken at random from each bag for measurements of the quantitative characters of the grain. The first hundred-grain sample was used to determine the volume of unhulled grains, while the second hundred-grain sample was used in the determination of the length, breadth, and thickness of the hulled grains and volume of the same 100 hulled-grain sample after being measured.

Grain weights

Each hundred-grain sample from 100 hills of each culture was weighed very carefully in an analytical balance, after which the hulls were removed and then reweighed. Because all the samples could not possibly be weighed within a very short time, in order to prevent loss of moisture from the unhulled grains, the writer weighed the one hundred-grain sample from the control first and then another from the experimental cultures, and so on, alternately. This method was followed in order to distribute any loss of weight during the time the samples were stored. In fact, this fluctuation and loss in amount of moisture may be considered a serious objection to the use of air-dry instead of oven-dry weight. The difference between the weight of the hundred unhulled grains and the weight of the same after hulling was considered in this paper as representing the weight of the hull, or paleas and glumes.

Grain size

All the metrical data (length, breadth, and thickness) of the hulled grain size were determined with a micrometer caliper that can easily be read to the hundredth of a millimeter. Altogether, 20,000 hulled grains from each culture were measured.

Grain volume

The volume of a hundred-grain sample taken at random from each of the 100 hills of each culture was determined. The volume of unhulled and hulled grains was determined by separate samples. The microburette was filled with tap water up to the 5th c. c. mark, and the hundred-grain sample was introduced into it through a glass funnel. Care was taken not to allow any air bubble to accumulate around the grains by gently tapping the burette. The volume of the displaced liquid or the difference in the readings made before and after introducing the sample into the microburette is considered the volume of the sample to be measured.

RESULTS AND DISCUSSION

Tillering

Time of tiller emergence.—Rice is typically a tillering plant, the "critical stage" of which is definite from sowing (Juliano, 1938). Tillering of the plants commenced almost at the same time in both cultures. In the control, the first tiller emerged and was visible out of the subtending leaf sheath on January 3, 1938, that is, twelve days from transplanting or twenty-seven days after seeding. It was not until the following day that tillers were observed among the experimental plants. In other words, tiller formation began in both cultures at approximately the same period after transplanting, that is, twelve to thirteen days, the experimental plants being delayed only for a day. In the can and field cultures conducted by Juliano (1938), two crops were planted, the first on November 3, 1936, and the second on August 8, 1937; tiller emergence took place twenty and twenty-six days after seeding, and nine and seven days after transplanting, respectively. It seems that the season of planting has something to do with the time of tiller formation even in a pure line, that is to say, in a palagad rice variety, summer planting tended to inhibit earlier tiller development.

Mean number of tillers.—In published works on a number of local rice varieties, Rodrigo (1924) and Calvo (1927) reported that an alteration in the tillering capacity of rice is effected by spacing, number of seedlings to the hill, varietal characters, and other factors of the environment. Working on the same variety as that used in this present work, Juliano (1938) found a significantly greater mean number of tillers per plant in can grown plants than in the field. He further found that the beginning of tiller formation was about a week from transplanting, which is very much earlier than what was found by the writer. Under natural conditions of growth, rice plants produce tillers a week after transplanting (Banerjee *et al*, 1936). Observations on western Bengal rices further show that the cessation of tiller formation was on the fifth or sixth week after transplanting for early varieties, but in late varieties, it may extend up to the eighth or ninth week. Ramiah (1927) says, however, that three to four, and five weeks, respectively, were what he observed for the above varieties in India. In the United States, field plants begin to tiller three weeks after seeding (Adair, 1936), and increase rapidly until the sixth week. Late tillers may be formed after this time, but they usually do not produce panicles and all that form panicles start growth within a period of three weeks after planting. Ramiah and Narashimhan (1936) observed that the tillering period of rice in India commences actively about two weeks after transplanting and is rapid during the three weeks following.

Analysis of the weekly mean increment of tillers per plant in both the shade- and open-grown plants from 150 hills in each treatment is given in table 1. In both groups of plants, a steady increase in the mean number of tillers per hill was found to commence at about the same time, that is, twelve to thirteen days after transplanting, and this increase in the mean number of tillers among the control plants covered a period of about six weeks or forty-one days from transplanting and fifty-six days or eight weeks from seeding. On the other hand, shaded plants exhibited a maximum mean number of tillers only after forty-eight days or about seven weeks from transplanting, and sixty-three days or nine weeks from seeding. This is well illustrated in figure 1. The data in table 1 show that shade tended to extend the number of days needed for all the tillers in the experimental plants to develop to the maximum. After the "critical stage" in tiller formation in each group was reached, that is, on February 1, 1938, for the plants grown in the open, and February 8, 1938, for the shaded plants, a slight increase or decrease was observed, resulting, perhaps from the death early or late tillers or from the formation of new late ones. The differences in weekly mean number of tillers per plant in both control and experimental treatments were insignificant after February 1, 1938, for the former, and after February 8, 1938, for the latter.

Results obtained by Juliano (1938) from his can grown plants indicate that the "critical stage" in tiller formation was reached forty-seven days or seven weeks from seeding, and thirty-six days or a little over five weeks from transplanting. Results obtained by the writer from his plants grown in the open do not coincide fully with those obtained by Juliano, in spite of the fact that both used the same pure line rice plants. This discrepancy may be explained as due to the difference of soils used, and the attendant weather conditions. Plants used by the writer were grown during the drier months of the year, whereas those of Juliano (1938) were grown during the rainy months of the previous years. The "pre-critical stage" limit found by the writer, however, in the formation of tillers is in conformity with the findings of Ramiah (1927), Ramiah and Narashimhan (1936), and Juliano (1938).

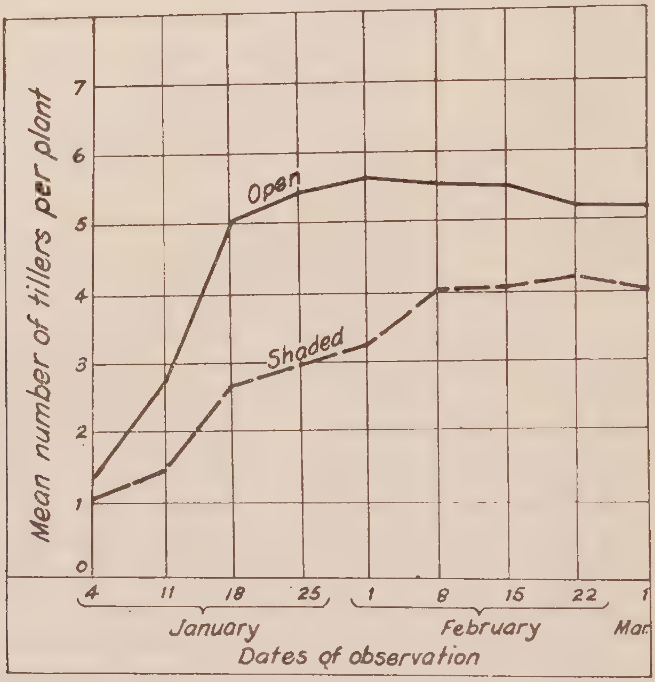

Fig 1.—Comparative weekly mean increment of tillers per plant.

Table 1 and figure 1 show that the experimental plants produced a lower mean number of tillers per plant than the control, and that the differences between their weekly means were all significant. In no case was the mean number of tillers more in the shade grown than in the open grown. The ratio between the maximum number of tillers per plant grown in the shade and those in the open was approximately 1:1.3 (see table 3).

The data in table 1 also indicate that variability among plants grown in the shade was more pronounced than among those in the open, the differences, however, were very slight.

Mean maximum number of tillers and bearing culms.—Increased yield are often the resultant of heavy tillering. The tillers produced, however, are not all equally contributory to the final yield. Juliano (1938) reports that can grown plants produced a significantly greater mean maximum number of tillers and bearing culms than similar ones grown in the field. Table 3 shows the mean maximum number of tillers and bearing culms from plants grown in the open and in the shade. From this table, it is easily seen that plants grown in the open have a significantly greater mean number of maximum tillers and bearing culms than those grown in the shade. When the mean maximum number of tillers and bearing culms obtained from plants grown in the open in this study are compared with those found by Juliano (1938) from his can grown plants, the figures herein presented are very much less, being only about one-third that found by Juliano (1938). This difference in the mean maximum number of tillers, even in the same pure line, might have been due to differences in soil conditions and climatic factors, inasmuch as plants used in this study were grown during the drier months of the year (December, 1938, to April, 1938).

Average height

Plants grown in the shade are much taller than those grown in the open (table 4, and figures 2 and 3). The mean average height of the shaded plants was significantly greater than that of the control plants. This seems to indicate that shaded plants spend more energy for growth in height than for the production of tillers. These results also explain why field plants growing along the edge of the paddy provided with shade are usually much taller than those in the more exposed portions of the same field, and consequently lodge more readily.

The data also indicate that plants grown in the shade exhibit much more variation as to their mean height than those grown in the open.

Length and width of leaf blades

The two dimensions of the blades of the last three leaves from 100 plants taken at random from among 150 hills in each treatment were measured before the plants were harvested. The length of the blade means the distance from the blade-joint to the apex of the leaf, whereas the breadth is the distance from the margins of the same blade midway between the blade-joint and the apex. Table 2 shows that the mean lengths in centimeters and the mean widths in millimeters of leaves from plants grown in the shade are significantly greater than those from leaves of plants grown in the open. All differences between their means are significant.

With the last leaf or flag, taken into account, it seems that in the discrimination of varieties, the angle formed by this leaf with the main axis of the plant can not be used as a varietal character, nor can its blade length and breadth (figure 3). The flag tended to be shorter and narrower and to be borne horizontally when rice was grown in the open, and broader and longer and held nearly at an angle of 22° when grown in the shade. Even in pure line, this flag character was not constant, and its size and how it was borne on the axis were dependent on external factors.

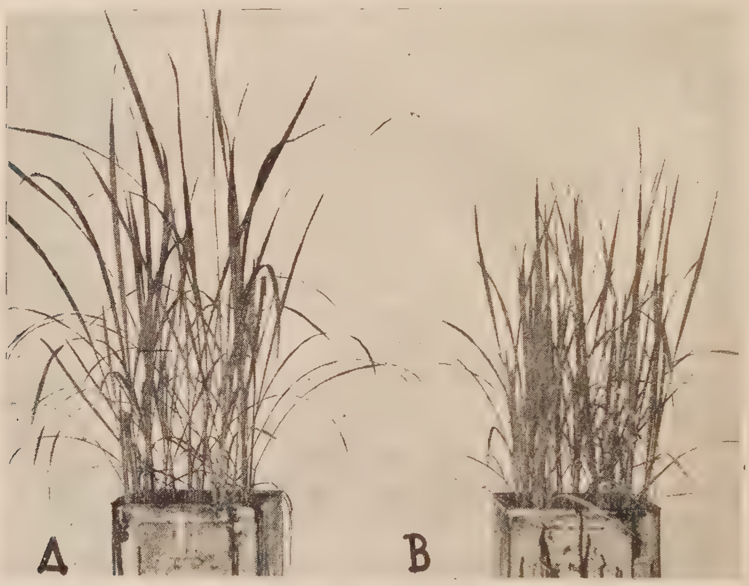

Fig. 2.—Comparative vegetative growth of plants 60 days after seeding. (*A*) Shaded and (*B*) open.

Booting and panicle emergence

Generally speaking, booting and emergence of the panicles under both treatments took place simultaneously. Booting was first noted in both cultures on March 1, 1938, that is, sixty-nine days from transplanting or eighty-four days from seeding. Emergence of the panicles from their corresponding leaf sheaths commenced on March 11, 1938, that is, seventy-nine days from transplanting or one hundred and four days from seeding.

The mean number of days required for every culm in each hill to boot is the period which elapses from the time the flag blade apex of the first culm has emerged from its subtending leaf sheath and the flag-blade of the last culm of the same hill has entirely emerged from its subtending leaf sheath. Plants grown in the open required slightly more than seven days (table 5) for the flag blades of every culm in a single hill to emerge completely, whereas plants grown under the shade required slightly more than six days; the difference was significant (0.9800 ± 0.1832 day.)

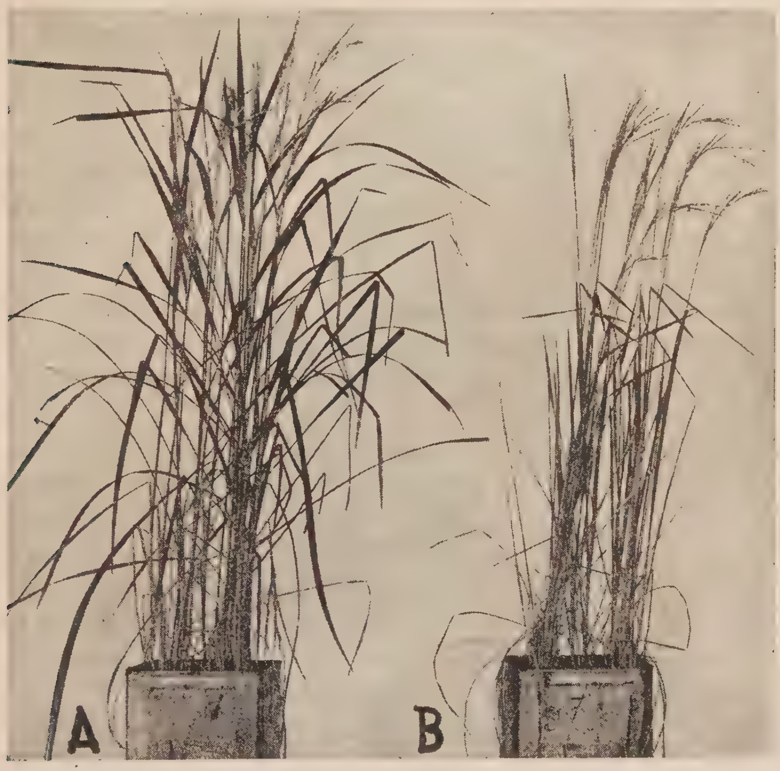

Fig. 3.—Comparative stand of plants at their reproductive stage, 104 days after seeding. (*A*) Shaded and (*B*) open.

The duration of panicle emergence was significantly longer among plants grown in the open than among those grown in the shade. This was to be expected as the plants in the open produced more bearing culms and, hence, required longer periods to complete these reproductive phases than did those grown in the shade.

Overlapping of the booting and emergence of panicles in each hill and in the cultures, resulting from the formation of late tillers, was observed. Booting took place as late as March 16, 1938, (15 days) and panicle emergence was about complete on March 21, 1938 (10 days). In general, all the culms in the hills under each treatment needed about a week to boot and another week to expose their panicles (table 5).

Peduncle

The peduncle, which bears the panicle or inflorescence, is the uppermost internode of the plant axis. A part of this is enclosed by the leaf-sheath of the flag, and that part which emerges from the sheath is the peduncle proper (Hector *et al*, 1934). The extent to which this emergence took place was measured by the vertical distance from the blade-joint of the flag to the first node where the basal rachillae of the inflorescence are borne, and the data on the mean length of the peduncle proper are given in table 7. These data were based on measurements of 100 plants taken at random from each culture.

Hector *et al* (1934) observed that in rich soil the emergence of the peduncle proper is much less than that of plants grown in poorer soil. Also, in years of good growth, there is greater emergence than in years of poor growth. The response of this character to shading is very well shown and illustrated in table 7 and figure 3. The mean length of the peduncle proper in plants grown in the open was significantly greater than that of the shaded plants. It is apparent, therefore, that even in a pure line, the degree of emergence of the peduncle proper is very variable, and, hence, is a character that can not be depended upon in classification studies.

Length of panicles

The length of panicles is one of the measures of productivity of rice plants. Panicle length as used in this paper is the distance from the first basal nodal insertion of the lower rachillae of the panicle to the tip of the uppermost grain. Statistical data of measurements of a hundred panicles taken at random from each of the cultures are given in table 6.

Table 6 shows that the mean length of the panicles from plants grown in the open is significantly less than that from plants grown in the shade. If the number of spikelets per panicle from plants in both cultures are to be considered (table 8 and figure 4), those plants grown in the shade produced a significantly greater number of spikelets than their sister plants grown in the open. A significantly greater mean length of panicles from plants grown in the shade indicates production of more spikelets. In fact, direct correlation was found between the mean length of the panicle and spikelet production of the same.

Maturation of spikelet

Mitra and Ganguli (1932) found that the time required for the opening of all the spikelets in a single panicle varies from five to nine days, the smaller panicles taking the shorter period. They further concluded that vigorous flowering was obtained on the second and third day. The highest rate of spikelet opening was from 10 to 11 a. m. on bright days and continued to 3 p. m. on rainy days. Juliano and Aldama (1937) presented data on the opening of the spikelets of rices, as given by various workers in other parts of the world, and this takes place as early as 6.25 a. m. and as late as 5 p. m. For example, Rodrigo (1925) found that anthesis takes place between 9 to 11 a. m., very infrequently between 6:25 and 9 a. m., and between 11:30 and 12:30 p. m.

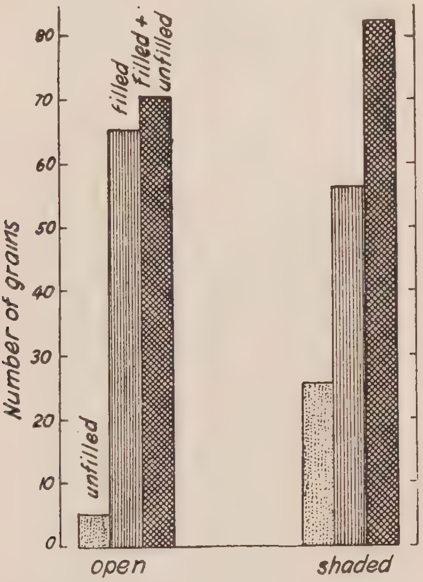

Fig. 4.—Relative characteristics of panicles.

Torres (1923) states that rice spikelets open between 9 and 11:30 a. m. while Juliano and Aldama (1937) found that the spikelets open between 9 a. m. and a little past 11:00 a. m. on bright sunny days. On cloudy and rainy days, however, opening may begin at 10:00 a. m. and completely cease at 11:00 a. m.; in some cases opening may be delayed as late as 1 to 2 p. m.

Among the plants studied by the writer, vigorous anthesis of the spikelets took place from 10:30 to 11:00 a. m. in plants grown in the open and from 11:00 to 11:30 a. m. and sometimes up to noon among those grown in the shade. During the opening of the spikelets of the plants under study, the weather was exceptionally clear and bright, as the observation was made during the month of March, 1938, when rain was scarce. There is thus a tendency for rice spikelets to open later at lower aerial temperature and reduced light intensity; this corroborates observations on cloudy days of workers.

A knowledge as to how many days from anthesis should elapse before the young developing caryopses could be harvested and still give a fairly high degree of germination is, indeed, very valuable. More than five hundred individual spikelets from different panicles taken at random from each culture were marked at anthesis for three consecutive days, and records of each spikelet were kept separately. From among these, grains were collected twelve days after anthesis, and every four days thereafter. The seeds thus collected were dried in the sun for a week. The different collections were then separately soaked in tap water overnight and germinated in separate petri dishes. The number of germinating grains were counted daily for several days, and results of such observations are given in table 10.

This variety is known to possess high germinability by the farmers of Calamba, Laguna, from where seeds used in this study were collected. When maturing rice panicles in the field happen to be overtaken by continuous rains, vivapary (figure 5) is not unknown. In fact, whether the grains had developed in the open or in the shade, they showed a fairly high germinating power even as early as twelve days from anthesis; those grains from shaded plants gave a lower germinating percentage (table 10). Not only did grains from plants grown in the open give a higher percentage of germination twelve days after anthesis, but also grains could be harvested for seed purposes from them as early as sixteen days after anthesis, whereas in the shaded plants similar seeds could only be obtained twenty days after anthesis. In other words, maturation of the grains in direct sun rays was much more rapid. Whether the grains harvested twelve days after anthesis from both cultures would yield just as much as those collected later has not been determined.

Table 10 shows that although grains from plants grown in the open always gave a higher percentage of germination, those from the shaded plants were more uniform in germination.

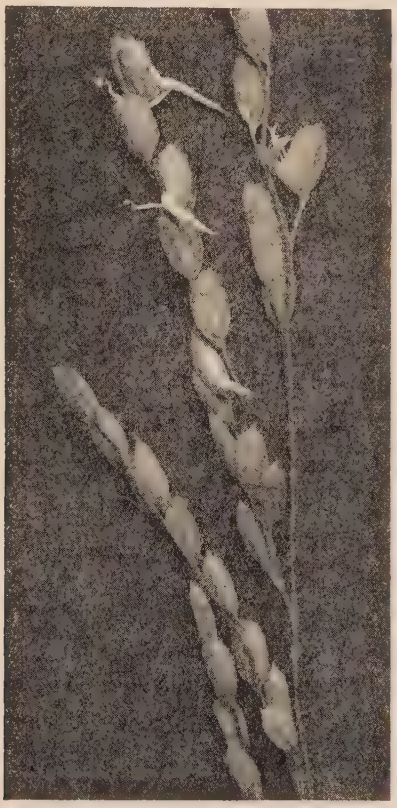

Fig. 5.—A case of vivapary in rice, Americano from Italy. Photographed July 2, 1938.

The actual period taken from the first commencement of flowering in a plant to grain ripening seems to be a varietal character and Parthasarathy (1927) found that with a very early variety, the grains were fully formed and gave 100 per cent germination nineteen days after anthesis and fertilization, whereas in late varieties, satisfactory germination was obtained after forty days. The grains of the variety used by the writer in this study were able to mature, even if grown in the shade, much earlier than the early varieties reported by Parthasarathy (1927).

Filled and unfilled grains

The number of filled and unfilled grains per panicle will give an idea of the amount of grain that can be obtained from a stand of rice plants as well as the relative size of the panicle of each culm. Filled grain production, however, is dependent on weather conditions, pests, and diseases obtaining from the emergence to the ripening stages of the panicles. How far shading affects the number of filled and unfilled grains per panicle is shown in table 8. The data in table 8 were based on 100 panicles taken at random from each culture.

Under the conditions existing in this study, panicles obtained from plants grown in the open gave a significantly higher mean number of filled grains than those grown in the shade. On the other hand, the mean number of unfilled grains per panicle in the shaded plants was higher than that from plants grown in the open. If the mean numbers of filled and unfilled grains per panicle were to be added and this sum taken to represent the total number of spikelets per panicle, it could be seen that the experimental plants yielded a higher number of spikelets per panicle than the control (figure 4). Measurements of the mean length of panicles from both cultures indicate that length has something to do with the number of spikelets a panicle may have. In fact, a direct correlation was found between the length of the panicle and the number of spikelets it bears. Grain production per panicle was significantly higher in plants grown in the shade than in their sister plants in the open. Mortality of the spikelets among plants in the shade was, however, significantly higher than among similar plants in the open.

Weight of grains and hull

As the hull is a total waste in the grain, a low percentage of it is a desirable quality in milling the rice. So far, no definite relation is known to exist between the size of the grain and the percentage of the hull (Mitra and Ganguli, 1932).

Unhulled grains.—The mean weight of a hundred-grain sample from shade grown plants is significantly lower than that of the plants grown in the open (table 9). This corroborates the findings of Montagnac (1937) wherein the average weight per hundred unhulled-grain sample of plants grown in the diffused light was much lighter (3.33 grams) than those grown in the open (3.50 grams). Furthermore, this same investigator reports that the weight per hundred unhulled-grain sample from plants grown in diffused morning sunlight and direct sunlight in the afternoon (3.73 grams), was much more than those grown in the open. This may mean either of two things: firstly, that the amount of hull is significantly more in grains from plants grown in the open than similar ones grown in the shade, or, the caryopses are significantly larger in the former than in the latter. These points will be discussed later in this paper.

Hulled grains.—After the hundred-grain sample from either culture was weighed, the hulls of the grains were carefully removed by hand, and then reweighed. Data of the weights of the hulled-grain samples are statistically presented in table 9. It was found that the mean weight of the hulled hundred-grain sample from plants grown in the open was significantly greater than that of plants grown in the shade—proof that direct correlation existed between the weight of unhulled and hulled grains.

Hulls.—The data presented in table 9 will also reveal that the proportion in weight of hulled grains to the hull is about 3:1 in both experimental and control plants. There is, therefore, a tendency for heavier unhulled grains to produce correspondingly heavier hulls. Hence, the claim that no relation exists between the weight of unhulled grains and that of the hull is not confirmed in this study.

Size of grains

A complete review of various works utilizing size of grains in the discrimination of rice varieties was given by Juliano (1938), and although various investigators vary in their opinion on the approximate size of grain samples to be used in a statistical study of grain size as given in this paper, the writer used a 100 grain-sample in his determination of the length, breadth, and thickness of the hulled grains, similar to that followed by Juliano (1938). As far as the writer is aware, no statistical measurements have yet been made to evaluate the effect of shade on grain size (hulled grain). Montagnac (1937), however, mentioned that diffused light increases the length and decreases the weight of the unhulled grains. He also reports that diffused light in the morning and direct sunlight in the afternoon are less effective in increasing the length and weight of the unhulled grains than direct light in the morning and diffused in the afternoon.

In table 11 are given the results of the measurements of the length, breadth, and thickness of the hulled grains. In this study a total number of 10,000 grains were used for each culture, or a grand total of 20,000. If the means from both cultures under each criterion of characters used in this study are to be compared with each other significant differences were obtained in all cases in favor of the plants grown in the open. In other words, hulled grains from plants grown in the open were significantly longer, thicker, and broader than those from plants grown under shade. Results on mean length of the hulled grains obtained in this study, therefore, do not corroborate the statement of Montagnac (1987) that diffused light, direct light in the morning and diffused light in the afternoon, and diffused light in the morning and direct light in the afternoon actually increase the length of unhulled grains. This investigator reports that rice plants in the field exposed to diffused sunlight produced much longer unhulled grains (9.95) millimeters) than those grown in the open (9.50 millimeters). Plants receiving direct morning sunlight and diffused afternoon sunlight produced longer unhulled grains (9.95 millimeters) than those which received direct afternoon sunlight and diffused morning sunlight (9.90 millimeters)

Juliano (1938) found an insignificant difference as to the mean length of hulled grains between can grown and field grown plants, whereas significant differences were found in the mean breadth and thickness, although the differences in the last two dimensions of the hulled grain were very small, so as to invalidate the use of these dimensional characters of hulled grains in rice classification. In the present study it was definitely found that shading has significantly decreased the mean length, breadth, and thickness of the hulled grains, so that in an attempt at classification, specially when size of hulled grains becomes an important desideratum, plants grown in the shade should not be utilized, as this factor greatly decreases the dimensional characters of the hulled grains. Grain size (hulled) is not entirely immune to the effects of environment, especially shading. Of all the characters studied however, including the vegetative ones, grain size is the least affected by shading.

Of the metrical atributes of the hulled grains, length tended to be the least variable and thickness the most inconsistent, a fact which confirms the findings of Juliano (1938) on hulled grains, and also Capinpin and Punyasingh (1938) on unhulled grains.

Volume of grains

The volume of grains will give one an idea of the quantity of harvest from a crop. How far the constancy of this character is affected by shading is shown in table 12. The data in table 12 were based on a total of 20,000 grains taken at random from each treatment, making a grand total of 40,000. The hulled grains were the same hundred-grain samples used for the dimensional characters, whereas the unhulled samples were taken at random from the same hills as the hulled samples had been obtained from.

As far as the writer could determine, no statistical report has been made on the volume of rice grains. Juliano (1938) made a non-statistical study on the volumes of hulled and unhulled grains, and therefore, it is hard to compare his results, with those reported in this paper.

Table 12 shows that grain-samples from experimental plants have significantly much less mean volume, either hulled or unhulled, than that of plants in the open. The data in table 12 also indicate a more pronounced variability of the volumetric character among the experimental plants than among those in the open, the differences being significant. If the mean length, width, and thickness of the hulled grains from each culture are compared with their respective mean volumes, an evident correlation between size and volume is observed. The hulled grains from the experimental plants were smaller and hence gave a correspondingly less mean volume than similar ones from the control plants (tables 11 and 12).

SUMMARY AND CONCLUSIONS

The present investigation gives data on the growth habit of can-grown Guinangang rice plants placed in the open and in the shade. The results obtained may be summarized as follows:

1. Shade greatly retards plants in reaching their "critical stage" in tiller formation. Plants grown in the open produced significantly more tillers than those in the shade; the former consequently produced a significantly greater number of bearing culms than the latter.

2. Plants grown in the open were significantly shorter than those in the shade.

3. The three upper leaves of plants grown in the shade were significantly longer and broader than those in the open. The angle formed by the flag with the main axis of the plant in the latter was greater than that from the plants grown in the former.

4. The time of booting and flowering did not seem to be altered by shading. The duration of booting, in a single hill, of plants grown in the open was longer than of those in the shade; this was also true with the mean duration of inflorescence emergence per hill.

5. The length of the peduncle proper was significantly greater in plants grown in the open than in those in the shade. Plants grown in the shade produced significantly longer panicles than those grown in the open; the former produced more spikelets than the latter, and, hence, direct correlation was obtained between panicle length and number of spikelets produced therefrom.

6. Grain maturation took place as early as twelve days after anthesis, irrespective of the treatment given them. Grains produced by plants grown in the open, however, were earlier to exhibit a hundred per cent germination than those formed by plants in the shade.

7. Plants in the open produced significantly more filled grains and less unfilled ones per panicle than those in the shade. If the total number of filled and unfilled grains be used as an index of the size of the panicle that bears them, the plants in the open produced smaller panicles than those in the shade, although the former had many more but shorter panicles per hill than the latter.

8. Plants in the open not only produced a significantly greater mean weight of hulls, but also significantly heavier grains (either hulled or unhulled) than those grown in the shade.

9. Hulled grains from plants grown in the open were significantly longer, thicker, and broader than those from plants in the shade.

10. The plants grown in the shade produced a significantly smaller volume of either hulled or unhulled grains per hundred-grain sample than the plants that were directly exposed to sunlight.

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TABLE 1

Analysis of weekly increase of number of tillers per plant

DATE OF OBSERVATION	MEAN			STANDARD DEVIATION		COEFFICIENT OF VARIATION		
	Open	Shaded	Difference	Open	Shaded	Open	Shaded	Difference
Jan. 4, 1938	1.4400 ± 0.0351	1.0266 ± 0.0090	0.4134 ± 0.0367	0.6375 ± 0.0248	0.1629 ± 0.0064	44.2708 ± 0.0203	15.8669 ± 0.0105	28.4039 ± 0.0229
Jan. 11, 1938	2.7333 ± 0.0561	1.4733 ± 0.0322	1.2600 ± 0.0647	1.0181 ± 0.0397	0.5854 ± 0.0228	37.2480 ± 0.0163	39.7305 ± 0.0171	2.4225 ± 0.0237
Jan. 18, 1938	5.0800 ± 0.0799	2.6000 ± 0.0157	2.4800 ± 0.0814	1.4501 ± 0.0565	0.2857 ± 0.0111	28.5446 ± 0.0120	10.9889 ± 0.0043	17.5557 ± 0.1199
Jan. 25, 1938	5.4400 ± 0.0918	2.9200 ± 0.0448	2.5200 ± 0.1022	1.6676 ± 0.0649	0.8138 ± 0.0317	30.6544 ± 0.0130	27.8685 ± 0.0117	2.7859 ± 0.0175
Feb. 1, 1938	5.6533 ± 0.0827	3.2733 ± 0.0492	2.3800 ± 0.0914	1.5011 ± 0.0586	1.0012 ± 0.0348	26.5526 ± 0.0112	30.9341 ± 0.0132	4.3815 ± 0.0173
Feb. 8, 1938	5.5866 ± 0.0829	4.0000 ± 0.0765	1.5866 ± 0.1129	1.5054 ± 0.0586	1.3893 ± 0.0541	26.9461 ± 0.1112	34.7315 ± 0.0132	7.7854 ± 0.1122
Feb. 15, 1938	5.5200 ± 0.0766	4.0333 ± 0.0752	1.4867 ± 0.1073	1.3903 ± 0.0541	1.4193 ± 0.0553	25.1858 ± 0.1040	35.1895 ± 0.0147	10.0037 ± 0.1050
Feb. 22, 1938	5.3466 ± 0.0774	4.1466 ± 0.0767	1.2000 ± 0.1090	1.4048 ± 0.0547	1.3929 ± 0.0542	26.2750 ± 0.0109	33.5913 ± 0.0144	7.2163 ± 0.0181
March 1, 1938	5.3933 ± 0.0973	4.0400 ± 0.0682	1.3533 ± 0.1190	1.7668 ± 0.0688	1.2376 ± 0.0482	32.7582 ± 0.0137	30.4876 ± 0.0139	2.2706 ± 0.0195

TABLE 2

Mean length in centimeters and width in millimeters of the flag and the first and second leaves below it

ITEMS	MEAN		Mean difference	STANDARD DEVIATION		COEFFICIENT OF VARIATION		Difference of coefficient of variation
	Open	*Shaded*		*Open*	*Shaded*	*Open*	*Shaded*	
LENGTH								
Flag	19.1800±0.2287	34.1700±0.4275	14.9900±0.4889	3.3902±0.1617	6.3385±0.3023	17.6793±0.0492	18.5498±0.0493	0.8705±0.0697
First leaf ...	33.0200±0.2760	62.3400±0.6394	29.3200±0.7139	4.0902±0.1951	9.3839±0.4475	12.3870±0.0477	15.0527±0.0486	2.6657±0.0751
Second leaf ..	38.9050±0.2902	69.9800±0.3675	31.0750±0.4635	4.3026±0.2052	5.4488±0.2599	11.3572±0.0528	7.7862±0.0037	3.5710±0.0529
WIDTH								
Flag	7.4500±0.4355	11.4850±0.0612	4.0350±0.4398	0.6456±0.3079	0.9663±0.0433	8.6658±0.0041	7.8950±0.0038	0.7708±0.0059
First leaf ...	6.9650±0.3163	10.7800±0.0735	3.8150±0.3247	0.4690±0.2237	1.0892±0.0520	6.7332±0.0032	10.1039±0.0523	3.3707±0.0612
Second leaf ..	6.6950±0.4169	10.6200±0.0480	3.9250±0.4197	0.6181±0.2948	0.7120±0.0340	9.2328±0.0044	6.7040±0.0032	2.5288±0.0057

TABLE 3

Mean maximum number of tillers and bearing culms per plant

ITEMS	OPEN	SHADED	DIFFERENCE
Mean	5.7800 ± 0.0083	4.2933 ± 0.0778	1.4867 ± 0.0783
Standard deviation	1.5145 ± 0.0059	1.4121 ± 0.0550	—
Coefficient of variation	26.2022 ± 0.0109	32.8000 ± 0.0141	6.6878 ± 0.0178
Mean	3.6466 ± 0.0566	2.9733 ± 0.0483	0.6733 ± 0.0744
Standard deviation	1.0271 ± 0.0400	0.8767 ± 0.0341	—
Coefficient of variation	29.3690 ± 0.0124	29.4867 ± 0.0113	0.1177 ± 0.0168

TABLE 4

Average height in centimeters of plants per hill

ITEMS	OPEN	SHADED	DIFFERENCE
Mean	82.6200 ± 0.3561	96.4866 ± 0.4064	13.8666 ± 0.5403
Standard deviation	6.4666 ± 0.2518	7.3787 ± 0.2873	—
Coefficient of variation	7.8269 ± 0.0031	7.6478 ± 0.0030	0.1796 ± 0.0100

TABLE 5

Mean number of days of booting and flowering per hill

ITEMS	DAYS OF BOOTING		
	Open	Shaded	Difference
Mean	7.0800 ± 0.1294	6.1000 ± 0.1272	0.9800 ± 0.1832
Standard deviation	1.9184 ± 0.0015	1.9184 ± 0.0900	—
Coefficient of variation	27.0960 ± 0.0138	30.9180 ± 0.0161	3.8220 ± 0.0212
	DAYS OF FLOWERING		
Mean	6.0800 ± 0.1335	5.6600 ± 0.1093	1.4200 ± 0.3526
Standard deviation	1.9791 ± 0.1944	1.6152 ± 0.0770	—
Coefficient of variation	32.5509 ± 0.0172	28.5369 ± 0.0147	4.0140 ± 0.0226

TABLE 6

Mean length in centimeters of the panicle

ITEMS	OPEN	SHADED	DIFFERENCE
Mean	20.5800 ± 0.1111	21.7400 ± 1.0885	1.1600 ± 0.4855
Standard deviation	1.6478 ± 0.0787	1.6138 ± 0.0780	—
Coefficient of variation	8.0068 ± 0.0038	7.4223 ± 0.0035	0.5845 ± 0.0520

TABLE 7

Mean length in centimeters of the exposed peduncle

ITEMS	OPEN	SHADED	DIFFERENCE
Mean	11.8200 ± 0.1439	7.3100 ± 0.1515	4.5100 ± 0.2090
Standard deviation	2.1335 ± 0.1018	2.2460 ± 0.1071	—
Coefficient of variation	18.0499 ± 0.0079	30.7250 ± 0.0013	2.6751 ± 0.0080

TABLE 8

Mean number of filled and unfilled grains per panicle

ITEMS	UNFILLED GRAINS		
	Shaded	Open	Difference
Mean	25.7600 ± 0.9465	5.0900 ± 0.0236	19.8600 ± 0.9481
Standard deviation	14.0321 ± 0.6694	3.5050 ± 0.0167	—
Coefficient of variation	54.4724 ± 0.1123	24.7839 ± 0.0510	29.6885 ± 0.1238
	FILLED GRAINS		
Mean	56.6000 ± 1.6650	65.2700 ± 1.3677	8.6700 ± 2.1547
Standard deviation	23.7957 ± 0.1177	20.2767 ± 0.9671	—
Coefficient of variation	42.0418 ± 0.0555	31.0659 ± 0.0521	10.9759 ± 0.0607

TABLE 9

Mean weight in grams of the unhulled grains, the hulled grains, and the hulls[a]

ITEMS	UNHULLED GRAINS		
	Shaded	Open	Difference
Mean	2.0120 ± 0.0079	2.3610 ± 0.0076	0.3490 ± 0.0110
Standard deviation	0.1174 ± 0.0056	0.1122 ± 0.0054	—
Coefficient of variation	5.8353 ± 0.0028	4.7502 ± 0.0023	1.0851 ± 0.0034
	HULLED GRAINS		
Mean	1.4980 ± 0.0073	1.7210 ± 0.0040	0.2230 ± 0.0083
Standard deviation	0.1082 ± 0.0052	0.0588 ± 0.0028	—
Coefficient of variation	7.2237 ± 0.0035	0.3417 ± 0.0002	6.8820 ± 0.0035
	HULLS		
Mean	0.4790 ± 0.0052	0.6065 ± 0.0073	0.1275 ± 0.0090
Standard deviation	0.0772 ± 0.0037	0.1080 ± 0.0052	—
Coefficient of variation	1.6118 ± 0.0008	1.7811 ± 0.0009	0.1693 ± 0.0012

[a] Based on hundred-grain sample. Difference between the weight of the unhulled and hulled grain sample gave the weight of the hull.

TABLE 10

Germination of grains of different ages

CULTURE	AGE OF GRAIN [a]	NUMBER OF SEEDS GERMINATING ON APRIL							GERMINATION
		20	21	22	23	24	25	26	
	days								*per cent*
Shaded	12	43	21	19	8	—	—	—	91.00
	16	93	5	—	—	—	—	—	98.00
	20	73	27	—	—	—	—	—	100.00
	24	96	4	—	—	—	—	—	100.00
	28	100	—	—	—	—	—	—	100.00
Open	12	48	35	9	4	—	—	—	96.00
	16	43	44	6	1	6	—	—	100.00
	20	82	18	—	—	—	—	—	100.00
	24	67	23	10	—	—	—	—	100.00
	28	77	17	6	—	—	—	—	100.00

[a] Age refers to the period from anthesis to the time of harvest.

It must be noted also that the samples were soaked overnight on April 17, 1938.

TABLE 11

Mean length, breadth, and thickness in millimeters of hulled grains

ITEMS	LENGTH		
	Open	Shaded	Difference
Mean	5.8670 ± 0.0012	5.7102 ± 0.0001	0.1568 ± 0.0124
Standard deviation	0.1835 ± 0.0009	0.1678 ± 0.0001	—
Coefficient of variation	3.1270 ± 0.0015	2.9393 ± 0.0033	0.1876 ± 0.0036
	BREADTH		
Mean	2.3283 ± 0.0006	2.2774 ± 0.0001	0.0509 ± 0.0006
Standard deviation	0.0861 ± 0.0004	0.0925 ± 0.0000	—
Coefficient of variation	3.6997 ± 0.0002	4.0697 ± 0.0000	0.3700 ± 0.0002
	THICKNESS		
Mean	1.6582 ± 0.0005	1.5458 ± 0.0006	0.1124 ± 0.0008
Standard deviation	0.0725 ± 0.0035	0.0905 ± 0.0004	—
Coefficient of variation	4.3690 ± 0.0002	3.5865 ± 0.0002	0.7825 ± 0.0003

TABLE 12

Mean volume in milliliters of the unhulled and hulled hundred-grain samples

ITEMS	UNHULLED GRAINS		
	Open	Shaded	Difference
Mean	1.9115 ± 0.0043	1.6070 ± 0.0114	0.3045 ± 0.0122
Standard deviation	0.0632 ± 0.0030	0.1695 ± 0.0081	—
Coefficient of variation	3.3057 ± 0.0016	10.5707 ± 0.0720	7.6250 ± 0.0720
	HULLED GRAINS		
Mean	1.2680 ± 0.0036	1.1370 ± 0.0176	0.1310 ± 0.0180
Standard deviation	0.0536 ± 0.0026	0.2615 ± 0.0011	—
Coefficient of variation	4.2294 ± 0.0020	22.9993 ± 0.0110	8.7699 ± 0.0112

AGRICULTURAL VALUE OF THE FINE EJECTA OF MAYON VOLCANO[1]

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Coronas (1898) gives some details of the occasional eruptions of Mayon Volcano from 1616 to 1897; Smith (1924) reports that it erupted in 1900 and in 1902; and Pendleton (1934) mentions its activity in 1903 and in 1928. From these records, it is evident that the occasional eruptions undoubtedly have been important in the formation and development of the soils in the province of Albay. The influence is very conspicuous along the sides of the newly constructed road to the barrio of Salvacion in the town of Libog, as evidenced by the boulders in the different soil horizons. The materials ejected by the volcano may affect not only their physical and chemical properties but also their biological condition.

Farm owners in the towns around the base of the volcano are of the opinion that the injurious effect of the eruption on the vegetation is momentary because the affected plants recover after a few months. All of the people in Albay say that the vegetation shows good growth a few months after the eruption. They believe that the volcanic ash fertilizes their fields.

Sherman (1929) reports that the dust of Mayon Volcano collected during an eruption contains potential food for abaca, namely, nitrogen, potash, and phosphoric acid. He further states that the dust is somewhat acid. As no detailed study of the agricultural value of the fine ejecta of Mayon Volcano has ever been made, this work was undertaken to determine the properties of the ash which made it valuable to agriculture: namely, plant-food reserve, total nitrogen, available potash and phosphoric acid, water soluble constituents, reaction, hygroscopic value, water-holding capacity, and certain microbiological properties.

MATERIALS AND METHODS

The ash used in this study was the same as that employed by the senior author in his study of the chemical and physical composition of the fine ejecta of Mayon Volcano (Galvez, 1938).[2] It contains all of the major constituents of rocks, and it is more or less loamy in texture. The amount of plant-food held in reserve was determined in accordance with the technique recommended by the Second Commission of the International Society of Soil Science as modified by Blanck and Rieser (1928); the total nitrogen, according to the methods of the Association of Official Agricultural Chemists (1935); the available or the citric acid soluble potash and phosphoric acid, by the method adopted by Lemmermann-Fresenius (1932); the water soluble constituents, by a procedure similar to that of Kawe (1932); the pH-value, by the quinhydrone electrode in pair with saturated calomel half cell; and the hygroscopic value and water-holding capacity, by the methods of Wiessmann (1926). The microbiological studies were made with the following methods being used: the number of bacteria and molds and the nitrifying power of the samples were determined according to the method followed by Aquino (1932); the occurrence of *Azotobacter* was determined by Winogradsky's method as described by Fred and Waksman (1928); and the sulfur-oxidizing power, by the same method reported by Aquino (1931).

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[1] Experiment Station contribution No. 1293. Read by Mr. J. P. Mamisao before the Los Baños Biological Club October 27, 1938.

RESULTS AND DISCUSSION

According to table 1, the volcanic ash contains all the inorganic constituents generally present in ordinary agricultural soils except nitrogen which occurred only as a trace in sample 1. Of the inorganic constituents Al_2O_3 gave the highest average amount and K_2O, the least. In order to have a knowledge of the plant-food reserve in the volcanic ash, the figures for the different constituents were compared with the plant-food reserve in Albay soils. Table 1 shows that in general the Mayon Volcano ash contained lower amounts of constituents which are soluble in 10 per cent HCl and had a lower loss on ignition than the Albay soils. The amount of insoluble residue in the ash and in the lava, on the other hand, was much higher than that of agricultural soils. With the exception of CaO the amounts of the fertilizing constituents were no better than those of agricultural soils. If volcanic ash is applied to the land, the plant food materials in the ash will be added to the soil with which they are mixed, and in the course of time, they will be made available to plants. Table 1 further shows that the fine ejecta studied contained relatively higher amount of SO_3 than the Albay soils. The high content of SO_3 is perhaps partly responsible for the injury to the leaves of many plants.

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[2] REV. MIGUEL SELGA, S.J., Director of the Philippine Weather Bureau in a letter to the senior author dated February 20, 1939, stated that a scientist by the name of Peralta collected volcanic ashes in Manila and in Sampaloc during the violent eruption of Mayon Volcano in 1814, and published a "*Breve análisis química practicada sobre las arenas volcanicas que eruptó el de Albay el dia 1º de Febrero y cayeron en la capital de Manila desde la noche del mismo hasta todo el dia dos y parte del tres del año 1814.*"

From this finding, it may be concluded that in order for the volcanic ash which was taken to the College of Agriculture to show properties similar to average soils, nitrogenous fertilizers should be added.

In regard to the content of available K_2O and P_2O_5 in the volcanic ash (table 2) it was noted that the amount of K_2O which plants can absorb varied from 11.56 to 14.48 milligrams per 100 grams of oven dry ash; the average was 12.87. This amount was much lower than that present in Albay soils. It is likewise lower than that given by Lemmermann (1932), who states that soils whose content of available K_2O is less than 15 milligrams per 100 grams of oven dry soil need potassic fertilizer. The volcanic ash, if used alone as a medium for growing plants, may respond to the addition of potash. Unlike K_2O, the average amount of phosphoric acid was more than twice the Lemmermann value. It was 41.46 milligrams of P_2O_5 per 100 grams. This value is much higher than the available P_2O_5 in the Albay soils. According to Lemmermann, soils containing more than 20 milligrams of P_2O_5 do not need phosphatic fertilizer.

The water soluble constituents of the Mayon Volcano ash, consisting mostly of SiO_2, CaO, Na_2O, and SO_3, compare favorably with those of the soils from Albay (table 3). The Mayon Volcano ash, however, contained relatively less soluble constituents (table 3a) than the ash from Taal (Cox, 1911). For this reason the Mayon Volcano ash can stand the leaching action of heavy rainfall longer than that of Taal Volcano.

The samples of Mayon ash used in this study had a texture similar to that of loam soils which are universally known to be fertile. The fine ejecta is good in its water-holding capacity which is 43.50 per cent (table 4). The writers found that the ash is fairly acidic. Sherman in 1929 reported that the ash which he collected from the eastern slope of Mayon Volcano during the eruption was acidic in reaction. This seemingly high hydrogen-ion concentration of the ash and the addition to the soil of available K_2O and P_2O_5 perhaps explain why good growth of vegetation may be noted a few months after the eruption. The low pH-value of the substance derived from the ash hastens the solution of the soil constituents which, otherwise, could not have been made available to the plant at the time that the ash fell to the ground.

The injury to the leaves of abacá (*Musa textilis* Née) and of papaya (*Carica papaya* Linn.) reported by Galvez (1938) was probably due to the presence in the air of large quantities of oxides of sulfur. This assertion is supported by the finding of large quantities of SO_3 as shown in table 1. The hygroscopic character of the Mayon Volcano ash (table 4) probably dehydrated the leaves on which it was deposited and produced localized yellowing, blackening, and wilting. The accumulation of ash on the leaves and the entrance into the leaves of an acidic solution (table 4) might also injure the foliage of many plants. In abacá Dr. José B. Juliano of the Department of Agricultural Botany found stomata on the upper surface of the leaves. The clogging of the pores of these stomata stopped transpiration and perhaps contributed to the abnormal appearance of the leaves. According to Doctor Juliano, papaya does not have stomata on the upper surface of the leaves.

Table 5 shows that the volcanic ash collected two weeks after the eruption contained colonies of bacteria and growths of molds. The presence of sulfur-oxidizing organisms was indicated by the oxidation of elemental sulfur and sodium thiosulfate into the sulfate form. In the 100-gram ash treated with one gram elemental sulfur and four grams of sodium thiosulfate, as high as 152.2 mgm. and 267.6 mgm. sulfur, respectively, were oxidized to the sulfate form.

Nitrification in the Mayon Volcano ash was negligible. Sample 3 oxidized its ammonium sulfate to the nitrate, whereas samples 2, 3, and 5 caused oxidation varying from 0.6 to 2.3 per cent.

The plaque test (Sackett, 1930), failed to show the presence of *Azotobacter*.

SUMMARY AND CONCLUSIONS

1. The 10 per cent HCl extract of the fine ejecta of Mayon Volcano contains all of the common inorganic soil constituents such as SiO_2, TiO_2, Al_2O_3, Fe_2O_3, Mn_3O_4, CaO, MgO, K_2O, Na_2O, SO_3 and P_2O_5. The amounts of these constituents are lower than those

present in average agricultural soils. For this reason the amount of insoluble residue is high. The loss on ignition is very low and no nitrogen is present.

2. With the exception of CaO the fertilizing constituents, like K_2O, and P_2O_5 are no better than those in ordinary soils.

3. The amount of available K_2O is lower than the limit given by Lemmermann. It is likewise lower than that found in Albay soils. P_2O_5, however, is much higher than the standard value or that found in Albay soils.

4. The concentration of the water extract of the volcanic ash is much lower than that of the ash of Taal Volcano, but compared well with that of the soils of Albay.

5. The fine ejecta of Mayon Volcano is hygroscopic and acidic in reaction. The wilting of the leaves of abacá (*Musa textilis* Née) and papaya (*Carica papaya* Linn.) may be attributed to oxides of sulfur liberated at the time of eruption, to dehydration of the cells of the leaves by the ash, and to the entrance into foliage of the acidic solution from the unusual deposit of ash on the leaves.

6. The samples of ash from Mayon Volcano collected two weeks after the eruption contained colonies of bacteria growths of molds and sulfur-oxidizing organisms. Nitrifying and *Azotobacter* organisms were absent. From the bacteriological standpoint the volcanic ash is rather poor.

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TABLE 1

Plant-food held in reserve in the fine ejecta and lava of Mayon Volcano and in Albay soils

CONSTITUENTS	SAMPLES OF FINE EJECTA FROM MAYON VOLCANO							MAYON VOLCANO LAVA	ALBAY SOILS	
	1	2	3	4	5	6	Average		Surface	Subsoil
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
SiO_2	0.38	0.35	0.33	0.38	0.40	0.30	0.36	0.40	0.26	0.32
TiO_2	0.40	0.38	0.42	0.44	0.35	0.36	0.39	0.42	0.20	0.25
Al_2O_3	5.27	4.77	3.66	5.45	5.05	3.81	4.67	3.32	8.08	10.15
Fe_2O_3	1.60	1.58	1.37	1.57	1.45	1.60	1.53	1.58	6.20	9.80
Mn_3O_4	0.10	0.09	0.08	0.07	0.09	0.07	0.08	0.00	0.00	0.00
CaO	3.02	2.15	1.84	2.19	1.89	1.94	2.17	1.18	1.37	0.99
MgO	0.27	0.26	0.11	0.15	0.27	0.15	0.20	0.21	0.24	0.18
K_2O	0.07	0.09	0.04	0.05	0.06	0.03	0.07	0.06	0.13	0.11
Na_2O	0.72	0.55	0.48	0.59	0.57	0.50	0.57	0.45	0.38	0.38
SO_3	0.46	0.35	0.41	0.40	0.44	0.46	0.42	0.06	0.11	0.11
P_2O_5	0.11	0.11	0.09	0.09	0.11	0.11	0.10	0.04	0.11	0.09
Loss on ignition ..	0.87	0.68	0.52	0.85	1.01	0.36	0.72	0.20	12.00	11.00
Insoluble in HCl	87.00	88.89	90.09	88.04	88.48	90.04	88.76	92.00	17.07	66.11
N	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.14
Total	100.27	100.25	99.44	100.27	100.17	99.78	100.04	99.92	100.37	99.63

TABLE 2

Available K_2O and P_2O_5 contents of the fine ejecta of Mayon Volcano and Albay soils in milligrams per 100 grams of oven-dry samples

SAMPLE NO.	K_2O	P_2O_5
1	11.56	48.42
2	12.78	40.45
3	12.44	46.08
4	12.92	37.12
5	13.01	37.12
6	14.48	39.56
Average	12.87	41.46
Albay soils		
Surface	17.88	10.10
Subsoil	13.60	9.25

TABLE 3

The water-soluble constituents of the fine ejecta from Mayon Volcano and of Albay soils

CONSTITUENTS	SAMPLES OF FINE EJECTA FROM MAYON VOLCANO							ALBAY SOILS	
	1	2	3	4	5	6	Average	Surface	Subsoil
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
SiO_2	0.022	0.036	0.068	0.088	0.051	0.082	0.058	0.014	0.018
Sesquioxides	0.008	0.016	0.032	0.014	0.012	0.020	0.017	0.016	0.016
CaO	0.077	0.062	0.077	0.022	0.034	0.035	0.051	0.040	0.080
MgO	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.010	0.019
K_2O	0.006	0.019	0.005	0.004	0.005	0.007	0.006	0.005	0.004
Na_2O	0.069	0.046	0.027	0.024	0.034	0.026	0.038	0.029	0.024
SO_3	0.067	0.029	0.022	0.022	0.037	0.036	0.036	0.087	0.142
Cl	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.001	0.001

TABLE 3a

Comparison of the amounts of the water-soluble constituents of the fine ejecta of Mayon Volcano and Taal Volcano

CONSTITUENTS	MAYON VOLCANO ASH	TAAL VOLCANO ASH [a]	
		Sample 1	Sample 2
	per cent	*per cent*	*per cent*
SiO_2	0.058	0.82	0.95
Sesquioxides	0.017	0.01	trace
CaO	0.051	0.16	0.32
MgO	0.003	None	None
K_2O	0.006	1.34	1.25
Na_2O	0.038	1.51	2.03
SO_3	0.036	0.30	0.60
Cl	0.003	0.74	0.95

[a] Cox, Alvin J. 1911.

TABLE 4

Physical properties of the fine ejecta of Mayon Volcano and Albay soils

MATERIALS	WATER-HOLDING CAPACITY	pH	HYGROSCOPICITY
	per cent	*per cent*	*per cent*
Mayon Volcano ash	43.50	5.10	0.97
Albay soils			
Surface	47.30	6.26	5.05
Subsoil	48.40	6.31	5.83

TABLE 5

Number of bacteria and molds, nitrifying power, sulfur oxidizing power, and occurrence of Azotobacter in some volcanic ashes ejected by Mayon Volcano in its recent eruption

SAMPLE NO.	NO. OF ORGANISMS IN 1 GM. OVEN DRY SOIL		NITRIFICATION—NO_3-N IN 100 GM. OVEN DRY SAMPLE			SULFOFICATION-SO-S IN 100 GM. OVEN DRY SAMPLE			AZOTOBACTER	
	Bacteria	Mold	Control	$(NH_4)_2SO_4$	$(NH_4)_2SO_4$ + $CaCO_3$	Control	S	$Na_2S_2O_3$	Control	$CaCO_3$
			mgm.	*mgm.*	*mgm.*	*mgm.*	*mgm.*	*mgm.*		
2	600,000	65,000	0	0.49	0	5.4	77.9	273.0	[a]	—
3	250,000	185,000	0	0.00	0	10.8	40.2	182.5	—	—
4	200,000	55,000	0	0.43	0.38	14.0	66.0	269.0	—	—
5	800,000	10,000	0	0.20	0.59	7.8	160.0	238.0	—	—

[a] Indicates absence of *Azotobacter* colonies.

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: XVI[1]

B. M. GONZALEZ
Dean, College of Agriculture

It was with pride that we announced in our fifteenth list of contributions of the College of Agriculture (1938)[2] that the Chief Executive of the Commonwealth had inserted in the 1938 budget "a substantial sum for improvement of research facilities in the College—all done spontaneously and without any campaign or solicitation on the part of this institution." The Chief Executive actually inserted in his first budget ₱50,000 for this purpose. Unfortunately, and certainly through no fault of his, the original plan somehow miscarried in the devious route of fund distribution. This sizable amount was intrusted, as is the normal course of procedure, to the University as a part of its total appropriation; the College of Agriculture in the end was doled out only ₱10,000, or exactly 20 per cent of the initial allotment. The depreciated sum was quickly absorbed by expenditures in badly needed equipment.

In spite of these handicaps—insufficient and antiquated equipment, inadequate pay, and frequent calls from other branches of the government, thus detracting our already short and over-worked personnel from its normal duties of instruction and investigation, we are still fortunate in being able to present a sizable list of contributions for the academic year just ending. This is due in large measure to the spirit of inquiry now deeply rooted in the personnel of the institution.

There is still the talk of concentrating the investigational work of the government in Los Baños, so that apparently the faith in the institution has not waned, but unless this is coupled with actual performance, it will be nothing more than blowing bubbles. It is very unfortunate that such an edifying task as the conquest of knowledge must depend on such material things as man, time, equipment and supplies, all of which can only be obtained through the medium of hard cash. It is gratifying to expect the institution not only to accomplish its functions successfully and even progressively but to do so on inadequate support; unfortunately, however, this cannot long endure. The foundations of the College are gradually being undermined. Experienced personnel, which after all are the mainstay of any institution, are beginning to cast their eyes on other fields, not so much for the remuneration itself but for the evident recognition of their worth that this implies.

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[1] General contribution No. 672. For earlier contribution lists see previous volumes of this journal.

[2] GONZALEZ, B. M. 1938. Published contributions of the College of Agriculture: XV. The Philippine Agriculturist 26: 907–913.

The College has gradually and painstakingly been built to its present position in the field of science and technical agriculture. It has been reaping a steady harvest of results that are invaluable in building up the foundation of the greatest industry of the country—agriculture. It would be regrettable not to take advantage of this momentum when the well-being of the Commonwealth is in such dire need of it.

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A LETHAL-LINKED KERNEL VARIATION OF LAGKIT CORN [1]

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WITH FOUR TEXT FIGURES

The kernel variation known in plant breeding and genetics as defective seeds is an illustration of defective germplasm widely distributed in cross-fertilized species like corn. According to Richey (1923), defective seed variation is an ancient character which was observed in maize some 300 years ago. It has even been contended that the seed variation of ancient maize was entirely similar phenotypically to some of those found to-day whenever maize is field pollinated.

Defective seeds of corn as a heritable character were reported first by Jones (1920). Subsequently other workers reported other specific types of defective seeds, which constitute a series of heritable characters in this species. Among such kinds of defective seeds may be mentioned: aborted seeds (Jones, 1920), with either entirely empty pericarps or badly shrivelled seeds; shrunken endosperm (Hutchison, 1921), in which the endosperm, failing to develop completely, often leaves a shallow space near the center of the grain; scarred endosperm (Eyster, 1922), in which "scar" appears as an irregular crater-like cavity in the endosperm on the abgerminal side near the crown of the kernel; mealy endosperm (Mangelsdorf, 1922), in which the corneous portion of the endosperm is partially or completely lacking; sweet and flint defectives (Lindstrom, 1923), which refer to endosperm defects of sweet and flint corn; germless seeds (Demerec, 1923), in which the endosperm is developed normally, but the embryo is almost or completely lacking; miniature germ (Wentz, 1924), in which the embryo and the germ area are very small; and undersized defective endosperm (Garber and Wade, 1924), in which the endosperm is characterized by milky appearing and slightly wrinkled pericarp, and which produces dwarf plants.

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[1] Read before the Los Baños Biological Club December 16, 1937. Experiment Station contribution No. 1294.

Object of this paper

The present paper is a report of the discovery in this College of a kernel variation in some Philippine corns and of the results of a study of the genetic nature of this variation.

Time and place of the work

The work was started in April, 1937, and concluded in December, 1937. The measurements and observations of the materials were conducted in the Plant Genetics laboratory and in the nursery of the Department of Agronomy.

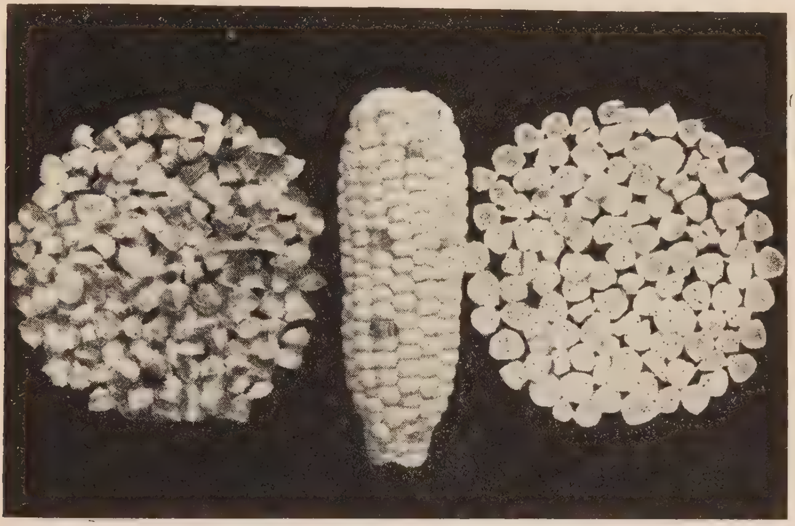

Fig. 1.—Grains at the left are the shrunken and wrinkled variants. At the middle is a Lagkit ear showing three defective kernels. At right are the normal kernels. Note the difference in texture and color of the normal and variant kernels.

MATERIALS AND METHODS

Occurrence of kernel variation. On April 2, 1937, while classifying the harvests of regional strains and first generation crosses of Lagkit corn, the writer observed off-type grains associated with normal Lagkit kernels. The Lagkit [2] grains are smooth, opaque, and pearly white. The variants are translucent with wrinkled, slightly shrunken, and horny endosperm. At first glance, these might easily pass as grains of sweet corn, but since they are slightly darker than the normal kernels, they are readily distinguished. The harvests of ears from thirty plots (200 sq. m. each) furnished the variants which were germinated. One to seven off-type kernels occurred on each ear. The frequency of occurrence seems not to be governed by the nature of parental seed corn, for the variants were found in both field pollinated strains of Laguna, Abra, and Cagayan Lagkit and progeny of their first generation crosses. The relative segregation of these kernel variants in a given Lagkit ear is shown in figure 1.

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On July 31, 1937, ears harvested from Purple and White Lagkit showed similar defective-kernels, the white and the purple variants. Except in color, they were in all respects phenotypically similar to what had been previously observed.

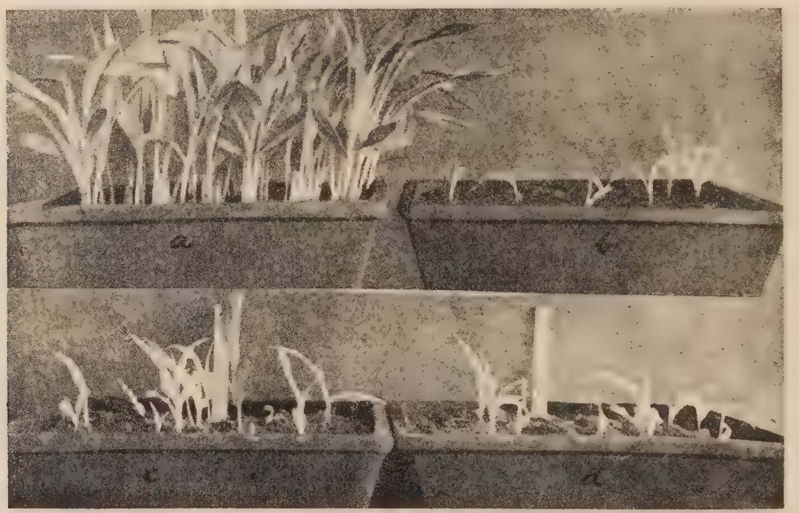

Fig. 2.—When the variant grains of Lagkit corn are grown separately from the normal grains of the same ear, a striking difference appears in the seedlings. Above are shown (*a*) normal grains giving normal green seedlings; (*b*), (*c*), (*d*), all variant grains producing albino seedlings. (May-sowing).

Experimental procedure. The thickness and width of 100 kernels of the variants and of the normal Lagkit corn taken at random were measured and their variation constants determined.

Sowings of the defective kernels were made as fast as they were collected primarily to see if the resulting ears were of the nature of sweet corn to which type these variants were suspected to belong. Normal kernels of the same ear were sown separately from the variant kernels to serve as control.

RESULTS AND DISCUSSIONS

Variability in grain dimensions. The relative width and thickness of the normal kernels were found to be significantly larger in dimensional measurements than those of the variant (see table 1). The degree of variability of the variant, however, was significantly higher than that of the normal kernels.

Germination and nature of seedlings. Table 2 shows the results of planting variant and normal grains of Lagkit. In general, the variant gave a relatively low percentage of germination; the range from the six sowings was from 5.5 to 99 per cent. The germination of the normal kernels ranged from 90 to 100 per cent. The variant grains differed markedly from the normal, not only in the ability to germinate, but also in the rate of growth of ensuing seedlings. Those of the variant were very slow growing as compared to the normal seedlings. Figures 2 and 3 clearly indicate their relative height, although both seedlings were sown and had germinated at the same time. The most significant characteristic observed immediately after germination was the deficiency in chlorophyll of the seedlings from the variant kernels. This chlorophyll deficiency was a true case of albinism, and all the resulting seedlings were albinos. On the other

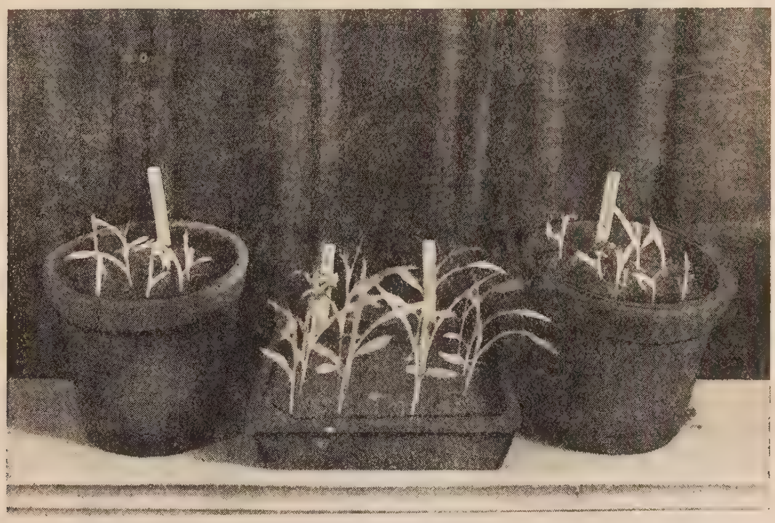

Fig. 3.—Purple variant in left pot, white variant, right pot, and normal grains in the seed pan in the middle. Both variants produce albinic seedlings, but not a single albino appears in the normal grains. (August-sowing)

hand, the normal Lagkit grains all produced normal green seedlings. The albinos, produced from both the purple and white variants, were evidently at a disadvantage as compared with the normal. As the plants grew older, the difference became greater. The albinic seedlings eventually starved to death since the absence of chlorophyll made it impossible for them to manufacture food. The albinos produced from seeds lived from eight to about eighteen days.

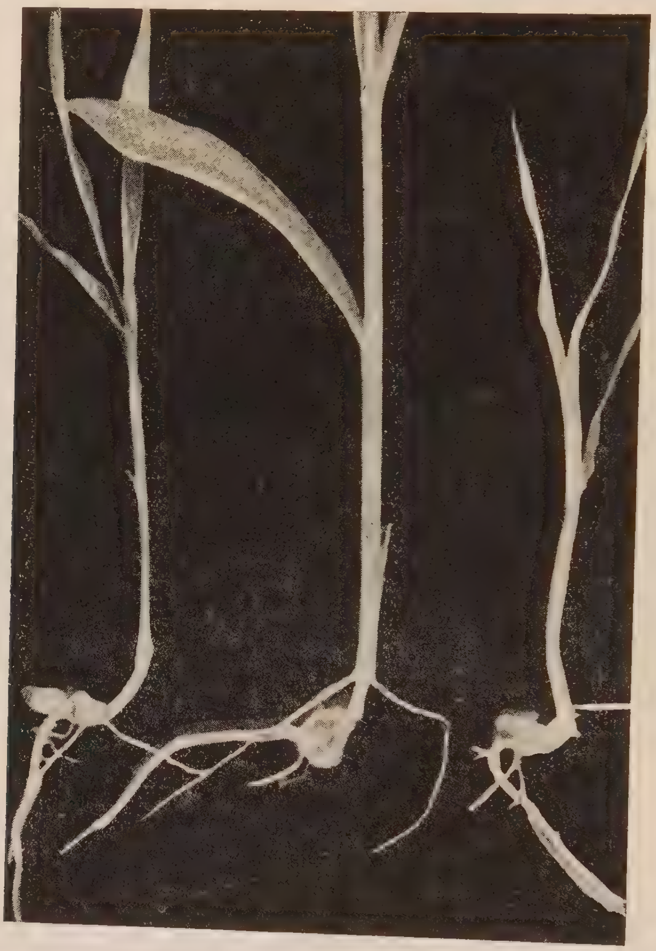

Fig. 4.—The shrunken and wrinkled endosperm type of grains showing complete linkage with albino seedlings. Photo taken when albino seedlings dried up.

Association between kernel variation and albinism. Because the defective seeds produced albinos and the normal, green seedlings, a complete association of defective kernels with white seedlings is indicated. This relationship might be considered a case of complete linkage between a lethal gene inhibiting normal Lagkit endosperm and another gene inhibiting the formation of normal chlorophyll. The seed variation may, therefore, be appropriately termed a lethal-linked seed variation. The lethal action of this kernel variation appears to be partially and intimately connected with insufficient food supply in the endosperm. This was revealed by the examination of seedlings at the time of death (see fig. 4). In normally green seedlings, eighteen days old, indications of the endosperm were still evident. In albinic seedlings of the same age, however, no more endosperm tissue could be seen. The insufficient nourishment in the seed and the deficiency of chlorophyll apparently account for the early death of the albinic seedlings. That complete linkage exists between this kernel variant and albinism was definitely established from the results obtained wherein not a single green seedling appeared from the variant kernels and not a single albino was produced from normal Lagkit kernel. Moreover, the lethal action of the defective kernels was independent of seed color, for the purple and white variant grains had invariably produced albinos.

Kernel variations similar to the case under report. As stated above, the shrivelled and wrinkled kernels were planted with the expectation that types similar to sweet corn might be produced. No seedlings, however, lived longer than three weeks. Of their sibs or the normal grains from the same ear that bore the variants, none produced variants again. From a genetic viewpoint, back-crossing with normal kernels should have been accomplished.

It is interesting to note that defective seeds had already been reported as partially or completely linked with albinism. Mangelsdorf (1922), for instance, found that mealy endosperm occasionally produced white seedlings. In this variation, the corresponding normal ears often segregate only green plants, which suggests that the relation may be physiological rather than a true case of genetic linkage. Again he described another seed defect characterized by the failure of embryo to go into the resting stage. This was observed in Century Dent and Canada Flint varieties, and the germinating seeds are just as lethal in action as any other extreme type with no food supply. A case of parallel significance is the endosperm defects called "sweet defective" and "flint defective" by Lindstrom (1920). These defective kernels usually either fail to germinate or produce such weak seedlings that they sooner or later perish. In other words, the flint defective showed complete linkage with albinic seedlings. This endosperm defect behaved as a simple Mendelian recessive. Jones (1920), reported a form of aborted seeds with either entirely empty pericarps or badly shrivelled seeds, completely lethal in action in some cases and partially so in others.

Genetic nature of kernel variation.—The frequency of occurrence of the seed variation under report was so low that its origin may be considered as mutational, the nature of which may be inferred from the recent findings in the genetics of maize kernel. Results show that the endosperm of maize is but another example of qualitative heritable character that is dependent on a large number of genetic factors for development. Besides the factors that control the physical texture of the endosperm of sweet, flint, dent, waxy, floury and waxy parts, some genes must exist that control directly the formation and complete development of the endosperm. The recessive alleles of these might be considered as lethal or semi-lethal factors from the endosperm developed. In the same manner, chlorophyll was shown to be a distinct genetic character involving at least twenty separate genes, ranging from completely lethal, producing white seedlings, to non-lethal, producing merely a pale or light green plant.

The seed variation described is one of the relatively large number of recessive characters which, when occurring in a homozygous condition, interferes with the efficiency of the corn plant as an organism, but which, nevertheless, may persist indefinitely in a heterozygous condition. As yet no data showing what effect this same character when heterozygous has on ontogeny of maize are available. In a field of corn plants, cross-fertilization tends to keep a character hidden from sight. Chance recombination, however, appears in a few plants heterozygous for the defectives, but since a few defective seeds are common on nearly every ear of corn, owing to various causes, such pass without particular notice. It would seem that the elimination of such defective characters would result in the improvement of corn production. At any rate, much of the present corn breeding is carried on with the view to eliminating certain characters which are decidedly undesirable when homozygous.

SUMMARY AND CONCLUSIONS

A seed defect characterized by wrinkled, shrunken, and horny endosperm arose in field-pollinated and first generation crosses of different regional strains of Lagkit corn. When sown, seed possessing this defect hardly germinated or produced albinos; that is, the defect showed complete linkage with albinism. The lethal action may be genetic, but evidences show that it may also be partly physiological on account of the small amount of endosperm to nourish the newly formed seedling. The variants were significantly smaller in dimensional measurements, but exhibited greater variability than normal Lagkit kernels. Purple and white defective kernels are both lethal-linked. This seed variation is perhaps but another example of defective germplasm, probably mutational in origin, the elimination of which is essential for corn improvement. Hence, this defect may fall in the same category as others proven to be recessive and undesirable variations.

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TABLE 1

Frequency distribution in dimensional measurement of normal and variant kernels of Lagkit corn

CLASS VALUE	FREQUENCY			
	Thickness		Width	
	Normal	Variant	Normal	Variant
mm.				
2	—	12	—	—
3	9	31	—	—
4	50	39	—	—
5	34	18	—	1
6	3	—	—	14
7	4	—	3	31
8	—	—	38	39
9	—	—	48	15
10	—	—	6	—
Mean (*mm.*)	4.40 ± 0.05	3.60 ± 0.06	8.53 ± 0.05	7.53 ± 0.06
S. D. (*mm.*)	0.85 ± 0.04	0.91 ± 0.04	0.73 ± 0.04	0.94 ± 0.05
C. V. (%)	19.30 ± 0.93	25.30 ± 1.22	8.50 ± 0.40	12.40 ± 0.60

TABLE 2

Seedling data of normal and variant kernels of Lagkit corn, 1937

CULTURE	SEED MATERIAL	DATE SOWN	NO. SOWN	GERMINATION	REMARKS
				per cent	
I	Variant white	May 5	150	6.0	9 albinos [a]
II	Normal white	May 5	100	95.0	all green
III	Variant white	May 21	90	5.5	5 albinos [b]
IV	Variant white	May 29	80	18.8	15 albinos [c]
V	Variant white	May 29	80	13.8	11 albinos [d]
VI	Normal white	May 29	50	100.0	all green
VII	Variant purple	Aug. 27	18	72.0	8 albinos [e]
VIII	Variant white	Aug. 27	9	99.0	8 albinos [f]
IX	Normal purple	Aug. 27	10	20.0	all green
X	Normal white	Aug. 27	10	100.0	all green

[a] Died May 16, at the age of 8 days.
[b] Died June 2, at the age of 10 days.
[c] Died June 13, at the age of 13 days.
[d] Died June 14, at the age of 14 days.
[e] Died Sept. 12, at the age of 13 days.
[f] Died Sept. 16, at the age of 18 days.

COLLEGE AND ALUMNI NOTES

Mr. U. Kojima and Mr. Seishi M. Ogawa both of the Ohta Development Company, Inc. visited the College of Agriculture on January 27, 1939. They were interested in the progress of the work on bunchy-top and mosaic diseases of abacá and on mosaic disease of the wild *Canna* from Davao. Mr. Kojima also saw the work on *Marasmius* disease of abacá, a minor trouble which develops in old abacá plantations under very humid conditions.

According to Mr. Kojima the abacá wilt in Davao is very destructive only at high altitudes. Although the wilt may also occur at lower altitudes (at Pendisaan and other places) owing to soil contamination or to planting of infected corms, he said that the disease is not serious. As the information came from the manager of the biggest abacá plantation in Davao, a man who knows much about diseases of abacá in the field through experience and gives lectures to Japanese abacá planters on how diseases of abacá may be recognized and controlled, it seems worthwhile to record that the statement corroborates observations by workers in the College of Agriculture who have seen the situation in Davao regarding the severity of the abacá wilt and its apparent relation to the distribution of *Odoiporus paganus* Uichanco (*The Philippine Agriculturist* **26**: 229–236. 1937; *College of Agriculture Biweekly Bulletin* Vol. 6, No. 2, June, 1937, and Vol. 6, No. 19, March, 1938, (mimeographed), and *Agricultural-Industrial Monthly* **4**: 8–9. 1937). Mr. Kojima further states that the abacá plantations of the upper Bayabas regions have been completely destroyed owing to the severity of the wilt disease.

The visitors also conferred with Dr. Pedro A. David of the Department of Agronomy.

At the regular scientific meeting of the Los Baños Biological Club held on December 15, 1938, the following papers were read and discussed:

Timber mining vs. sustained yield in U. P. Land Grant, Basilan, Zamboanga. By Mr. Justino Seguerra.

Studies on the manufacture and uses of rimas flour. By Dr. V. C. Calma.

Cost of producing pigs at the College of Agriculture. By Dr. M. Mondoñedo.

At the regular scientific meeting of the Club held on January 26, 1939, the following papers were read and discussed:

The food of 158 families in Ramain, Lanao. By Dr. F. O. Santos and Dr. P. S. Hamoy, District Health Officer, Dansalan, Lanao. The paper was read by Doctor Santos.

An analysis of the report of the Joint Preparatory Committee on Philippine Affairs. By Professor José E. Velmonte.

Chemical fertilizers used in various sugar centrals in the Philippines. By Dr. Rafael B. Espino.

United States Army officers held on the Campus of the College of Agriculture their closing conference in connection with their recent maneuvers in the neighborhood of Mount Maquiling.

The following alumni of the College of Agriculture have been appointed to the faculty of the College: Mr. José Borromeo, '36, Assistant Instructor in Agricultural Chemistry, effective December 2, 1938. Mr. Ruperto Evangelista, '37, Assistant Instructor in Animal Husbandry, effective November 17, 1938.

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